INSTRUCTION MANUAL

MTS MODELS 410:21

EXACT Electronics, Inc.

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s/n

EXACT
Electronics, Inc

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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

C O N T E N T S

SECTION 1	SPECIFICATIONS, DESCRIPTION
SECTION 2	OPERATING INSTRUCTIONS
SECTION 3	CIRCUIT DESCRIPTION (refer to this section for troubleshooting)
SECTION 4	CALIBRATION
SECTION 5	CIRCUIT DIAGRAMS
SECTION 6	PARTS LIST

SECTION 1 SPECIFICATIONS DESCRIPTION

SECTION 1.0.0 . . . . . SPECIFICATIONS

VISUAL REQUIREMENTS

1. Following inputs/outputs on rear terminal barrier strips.

   Remote frequency dial (A1, A2, B1, B2)
   +Main output
   -Main output
   Ground
   Gate input
   Trigger out

2. Front panel banana jacks

   Selected functions out (main output)
   Square out
   Triangle out
   Sine out

3. Power switch and fuse on rear

4. Two instructions manuals with each unit

5. General packaging - etched aluminum chassis, silk screened and lacquered. G 10 class epoxy P.C. boards with 18 pin, 5200 and 3200 series Elco connectors. Weight 12 pounds, dimensions 10.5" deep by 16.75" wide by 3.5" high.

ELECTRICAL

1. Front panel outputs (Main 12 positions)

Square	Inverted Square
Triangle	Inverted Triangle
Sine	Inverted Sine
Haversine	Inverted Haversine
Ramp	Inverted Ramp
Hold Ramp	Inverted Hold Ramp

   Auxiliary Square (banana jack)
   Auxiliary Triangle (banana jack)
   Auxiliary Sine (banana jack)

2. Rear panel outputs

   A1, A2 shorted together when using internal timing dial.
   A2 Ext Timing dial (wiper of external variable timing pot)
   A1 not used, Ext Timing dial

   B1, B2 shorted together when using internal timing dial.
   B2 Ext Timing dial (to top of external variable timing pot
   B1, not used, Ext Timing dial

   Main out
   Inverted output same as main output specifications
   Trigger out (square waveform)
   Ground

ELECTRICAL (continued)

3. Inputs

   Gate input (may be open circuit)
   ON +5 volts minimum (+50 volts maximum signal)
   OFF +2 volts maximum, +1 volt minimum
   duration vs cycle - up to 99% of cycle period

4. Operating Modes - free-running, triggered, control panel (gated), hold-interrupt (Hold Ramp only)

5. Waveform Symmetry - better than 99.5% (time)

6. Main Output (1) (-) 10 or 20 volts (depending on waveform) into 500 ohms (minimum P-P).

7. Auxiliary outputs - 24 volts (minimum) into 5K ohms.

8. Frequency Range - 0.001CPS to 1KC in six decades.
   *Accuracy - Tracking 1%, dial, (absolute) decade 2%
   *Stability - Short term (jitter)
   Long term (24 hours) .2%

9. Amplitude vs Frequency

   Square - less than 10mv
   Triangle - less than 10mv to 100CPS; 300mv 100CPS to 1KC
   Sine - less than 10mv

10. DC Shift vs Frequency (Square, Triangle, Sine)
    not measurable - less than 10mv

11. Hum and Noise - more than 70db down from full amplitude

SPECIFIC WAVEFORMS

	+	-	Aux.
1. Square			
**Amplitude (Adj.)	<9V	>11V	24V fixed min P-P
Amplitude Stability	25mv	25mv	25mv
D.C. Level (±25mv)	0 Base	0 Base	0 Center
D.C. Stability	within 25mv	within 25mv	within 25mv
Deviation from flatness	0.1%	0.1%	0.1%
Time (rise and fall)	5μsec	5μsec	5μsec
2. Triangle			
**Amplitude (min. P-P)	<9V	>11V	24V
Amplitude Stability	25mv	25mv	25mv
D.C. Level (±25mv)	0 Base	0 Base	0 Center
D.C. Stability	within 25mv	within 25mv	within 25mv
Linearity	99.8%	99.8%	99.8%

*Typical operation at least 50% better than stated specifications
**Adjustment made with a load of from 450 ohms to 550 ohms

SPECIFIC WAVEFORMS (continued)

3. Sine

	+	-	Aux.
Amplitude (min P-P)	18 to 22V	18 to 22V	24V
Amplitude Stability	25mv	25mv	25mv
DC Level (center) ±25mv	0	0	0
DC Stability	within 25mv	within 25mv	within 25mv
Harmonic Distortion	less than 1%	less than 1%	less than 1%

4. Haversine

*Amplitude (min P-P)	<9V	>11V	none
Amplitude Stability	within 25mv	within 25mv	none
DC Level (±25mv)	0 Base	0 Base	0 Center
DC Stability	within 25mv	within 25mv	none
Harmonic Distortion	less than 1%	less than 1%	none

5. Ramp

*Amplitude (min P-P)	<9V	>11V	none
Amplitude Stability	within 25mv	with 25mv	none
DC Level (±25mv)	0 Base	0 Base	0 Center
DC Stability	within 25mv	within 25mv	none
Timing (dvdt)	2X dial	2X dial	none
Linearity	99.8%	99.8%	none
Falltime	--less than 1% of period to 0.01CPS--		
	--less than 10% of period 0.01CPS to 1KC--		

6. Hold Ramp

*Amplitude (min peak)	9.5V	9.5V	9.5V
Amplitude Stability	within 25mv	within 25mv	within 25mv
DC Level (±25mv)	0 Base	0 Base	0 Base
DC Stability	within 25mv	within 25mv	within 25mv
Slope	same as ramp	same as ramp	same as ramp
Linearity	99.7%	99.7%	99.7%
Peak Catch	9.5V	9.5V	9.5V
Hold Stability	--------0.1% of period----------		
Reset falltime	------less than 10% of period --		

CHARACTERISTICS

1. Function Switch

The function switch selects the type of waveform that will appear at the main output jack. The hold ramp (_/‾ or ‾_) position of the function switch is operational only when the mode switch is in the manual trigger position.

2. Run-Disconnect

This switch is a temporary elimination of switching transients. Switching to "disconnect" grounds the main output and inserts high-speed timing. This insures that after logic and function switching is done the waveform levels

*Adjustment made with a load of from 450 ohms to 550 ohms.

CHARACTERISTICS (continued)

will be at "0" when the "run-disconnect" switch is returned to the "run" position. (NOTE: When "disconnect" is made in the .01 or .001 timing positions, allow five seconds before returning to "run".)

3. Main Out

In "free-run" operation the output will be as indicated by the function switch EXCEPT for RAMP-HOLD positions, where the output will be zero volts.

In external control (gate and trigger) outputs will be as indicated.

4. Auxiliary Outputs

FUNCTION SWITCH SETTING	SQUARE	TRIANGLE	SINE
Sine ±		-----As Indicated-----	
Triangle ±		-----As Indicated-----	
Square ±		-----As Indicated-----	
Haversine ±		-----As Indicated-----	
Ramp ±	NA	As Indicated	NA
Ramp Hold ±	NA	As Indicated	NA

5. Ramp Hold

These functions are available only in Manual Trig mode. With the HOLD-RUN switch in RUN, the ramp can be triggered and will rise at a rate equal to the reciprocal of 1/2 the frequency setting. The ramp can be reset at any time by pressing the Reset button or held by placing the Hold-Run switch in Hold. (The Reset button will override the Hold-Run switch and always return the ramp to zero volt). If the ramp is not held or reset it will rise to peak voltage and remain. If the Run-Disconnect switch is used in Ramp-Hold operation, the ramp should be reset before disconnecting.

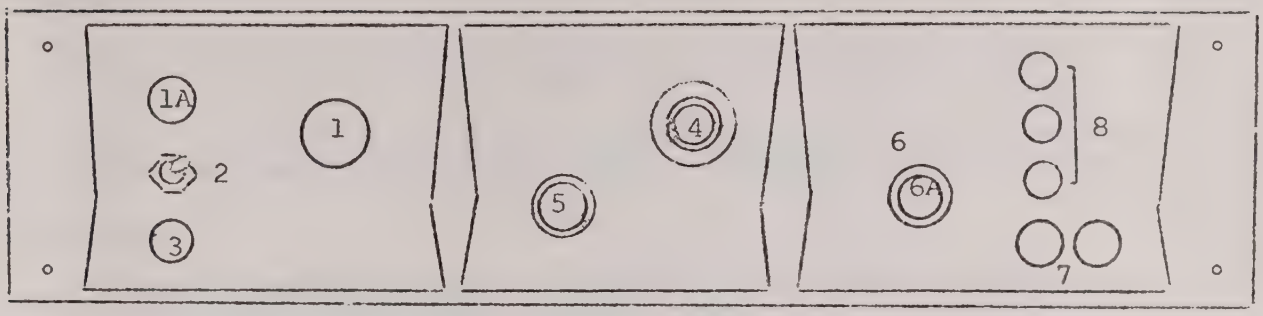
The above features were incorporated for use with the Ramp-Hold function only. There will be outputs for the other waveforms but no attempt has been made to control or specify them. Therefore they should be used with caution and discretion.

6. Specifications

All quoted specifications are based on 30-minute warm-up time and relatively stable ambient temperatures.

SECTION 2 OPERATING INSTRUCTION_

LOCATION OF FRONT PANEL CONTROLS



CONTROL MODE

1. Control switch	Three position switch Free Run: All waveforms run continuously except the Hold Ramp. Control Panel Run: permits gating by an external voltage. Manual Trigger: unit may be triggered for one cycle by pushbutton (1A). This mode is also used to program the Hold Ramp function.
2. Hold Run switch	Intercepts and continues ramp slope in the Manual Trigger mode only.
3. Reset button	Resets the Hold Ramp function.

FREQUENCY

4. Frequency Range switch	Changes frequency in decade units.
5. Frequency vernier dial	Continuously varies frequency within decade range.

FUNCTION

6. Selector switch	Selects any one of twelve functions (6A). Run-disconnect switch reduces switching transients when logic is changed.
7. Main output	Main Output source jack and Main Output ground jack.
8. Auxiliary outputs	Auxiliary output jacks - Sine, Triangle and Square.

FIRST TIME OPERATION

GENERAL

Plug instrument into an AC outlet of proper line voltage. Turn instrument on and let run twenty minutes to stabilize.

Connect a cable to the Main output source (7) of the generator. a 500-ohm load is the proper termination for the instrument.

FREE RUN

Set the Frequency vernier dial (5) to the desired frequency.
Set the Control switch (1) to Free Run.
Set the Selector switch (6) to the desired function.
Set the Frequency Range switch (4) to proper range.

The generator will be free running at the frequency set by the Frequency vernier (5) and the Frequency Range (4).

Three waveforms (square, triangle and sine) are simultaneously available at the auxiliary outputs (8). The Main output (7) is used to select a single function waveform. Any function can be selected except the Hold Ramp in the Free Run mode. All wave forms have fixed amplitudes and are simultaneous and synchronized.

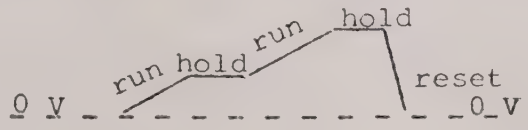
MANUAL TRIGGER

Set the Control switch (1) to Manual Trigger. One cycle is triggered each time the pushbutton (1A) is pressed.

±HOLD RAMP

Set the Hold Run switch (2) to Run.
Set the Selector switch to + or - Hold Ramp.

Press the pushbutton (1A) to start function. Switch the Hold Run switch to hold at desired level. (Repeat as often as desired until peak is reached.) The Reset button (3) will return the Ramp to zero volts from any level when in either the Hold or Run condition.



CONTROL PANEL RUN

Set the Control switch to Control Panel Run. Apply an external signal to the Gate In (on rear panel). As long as a gate signal is applied, the instrument will free run.

SECTION 3 CIRCUIT DESCRIPTION

This section gives a brief description of the instrument's circuitry in the following order.

Power Supply

Gate Lockout

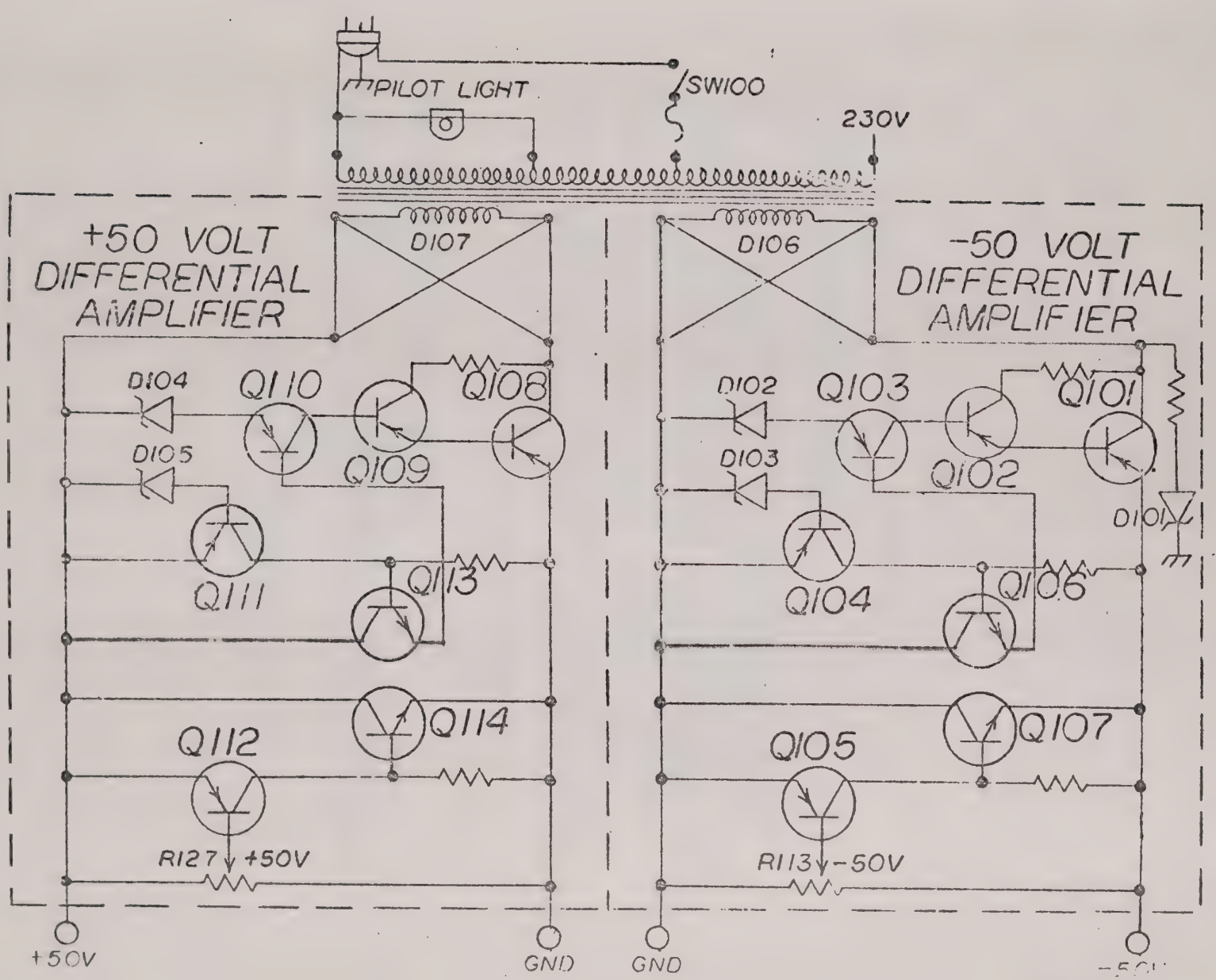
Integrator

Schmitt

Sine Shaper

Sine Amplifier

POWER SUPPLY



POWER SUPPLY

The Power Supply P.C. board provides the following voltages:

1. +50 volts
2. -50 volts
3. 24 volts unregulated

Functionally it operates as follows:

+50 VOLT DIFFERENTIAL AMPLIFIER

Q104-Q107 form a differential amplifier which compares the voltage across D103 to the power supply voltage. The output from Q106 is further amplified by Q103. The output of Q103 is applied to the Darlington pair, Q101-Q102. The output of Q101 is the regulated supply voltage. The regulator receives its power from the power transformer through D106, the bridge rectifier.

The power from D106 is also used to supply 24 volts relay power which is controlled by the zener diode D101.

R113 (-50 volt) adjusts -50 volt power supply.

-50 VOLT DIFFERENTIAL AMPLIFIER

Q108-Q112 form differential amplifier whose operation is identical in all respects to the +50 volt differential amplifier.

R114 (+50 volt) adjusts +50 volt power supply.

GATE LOCKOUT

SCHMITT MULTI

LOCKOUT MULTI

Q604

Q603

Q602

Q601

O 17 50

O 16 GND

O 15 50

O 14 TRIG. IN

O 13 GATE

O 12 CONTRO

O 11 TRIGGER

O 10 RUN

O 9 GND

O 8

O 7

O 6

O 5 50

O 4 GND

O 3 50

O 2

O 1

GATE LOCKOUT

The Gate Lockout P.C. board generates a lockout voltage which controls the operation of the Integrator P.C. board.

Functionally it operates as follows:

LOCKOUT MULTIVIBRATOR

Q601-Q602 form a lockout multi which supplies the control voltage to the Integrator P.C. board through pin 11 and receives the reset signal from the Schmitt P.C. board through pin 18.

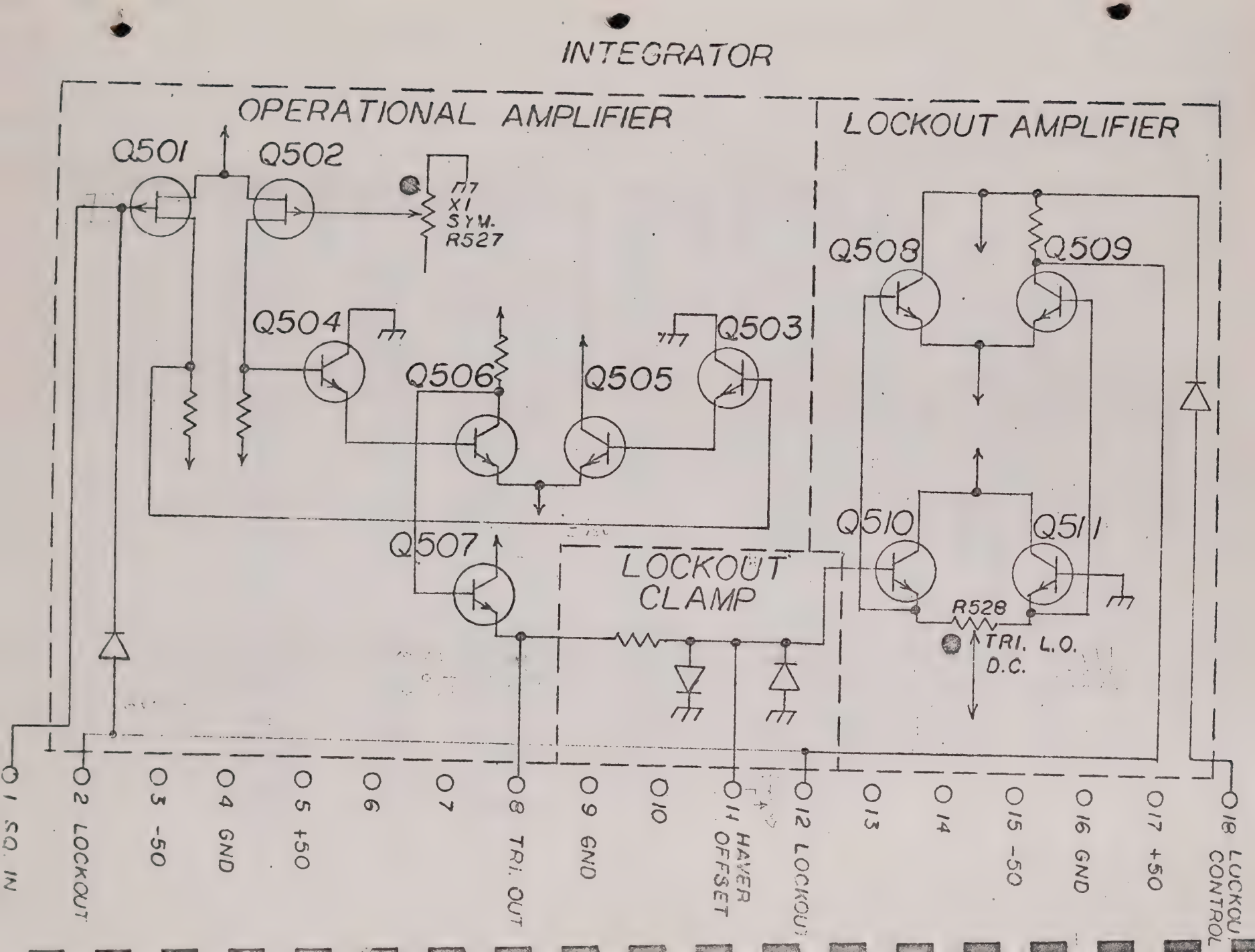
SCHMITT MULTIVIBRATOR

Q603-Q604 form a Schmitt Multi which controls the Lockout Multi (Q601-Q602) depending on the setting of the Mode switch.

Free Run: A negative voltage at pin 18 causes zero volts at pin 11.

Manual Trigger: Switching to this mode removes negative voltage at pin 10, causing positive voltage at pin 11 to lock out Integrator P.C. board.

Control Panel Run: The operation in this mode is identical to the Manual Trigger mode described above except that the D.C. voltage fed to pin 13 is connected (via the Mode switch) to pin 12. This blocks the square wave at pin 18 from resetting at the end of one cycle. Free run operation continues until the gate pulse is removed. At this time Q603-Q604 reverts, the blocking DC voltage is removed and the next square cycle flips Q601-Q602 and locks out the Integrator P.C. board.


INTEGRATOR
OPERATIONAL AMPLIFIER
LOCKOUT AMPLIFIER
Q501
Q502
R7
X1
SYM.
R527
Q504
Q503
Q506
Q505
Q507
LOCKOUT
CLAMP
Q508
Q509
Q510
Q511
R528
TRI. L.O.
D.C.
O1 SQ. IN
O2 LOCKOUT
O3 -50
O4 GND
O5 +50
O6
O7
O8 TRI. OUT
O9 GND
O10
O11 HAVER OFFSET
O12 LOCKOUT
O13
O14
O15 -50
O16 GND
O17 +50
O18 LOCKOUT CONTROL

INTEGRATOR

The Integrator P.C. board generates the triangle waveform which

1. Furnishes the triangle waveform to the Schmitt P.C. board.
2. Furnishes auxiliary triangle output.
3. Drives the sine shaper.

Functionally it operates as follows

OPERATIONAL AMPLIFIER

Q501-Q507 form a high-gain, high-stability operational amplifier to perform high accuracy computation of the triangle waveform from the square provided by the Schmitt P.C. board. The output through pin 8 supplies a low impedance triangle to the auxiliary outputs. R527 (X1 Sym.) balances Q501 and Q502.

LOCKOUT CLAMP

The purpose of the lockout clamp is to furnish a small sample of the triangle waveform, which has been clipped by diodes D502-D503, to emitter followers Q510-Q511.

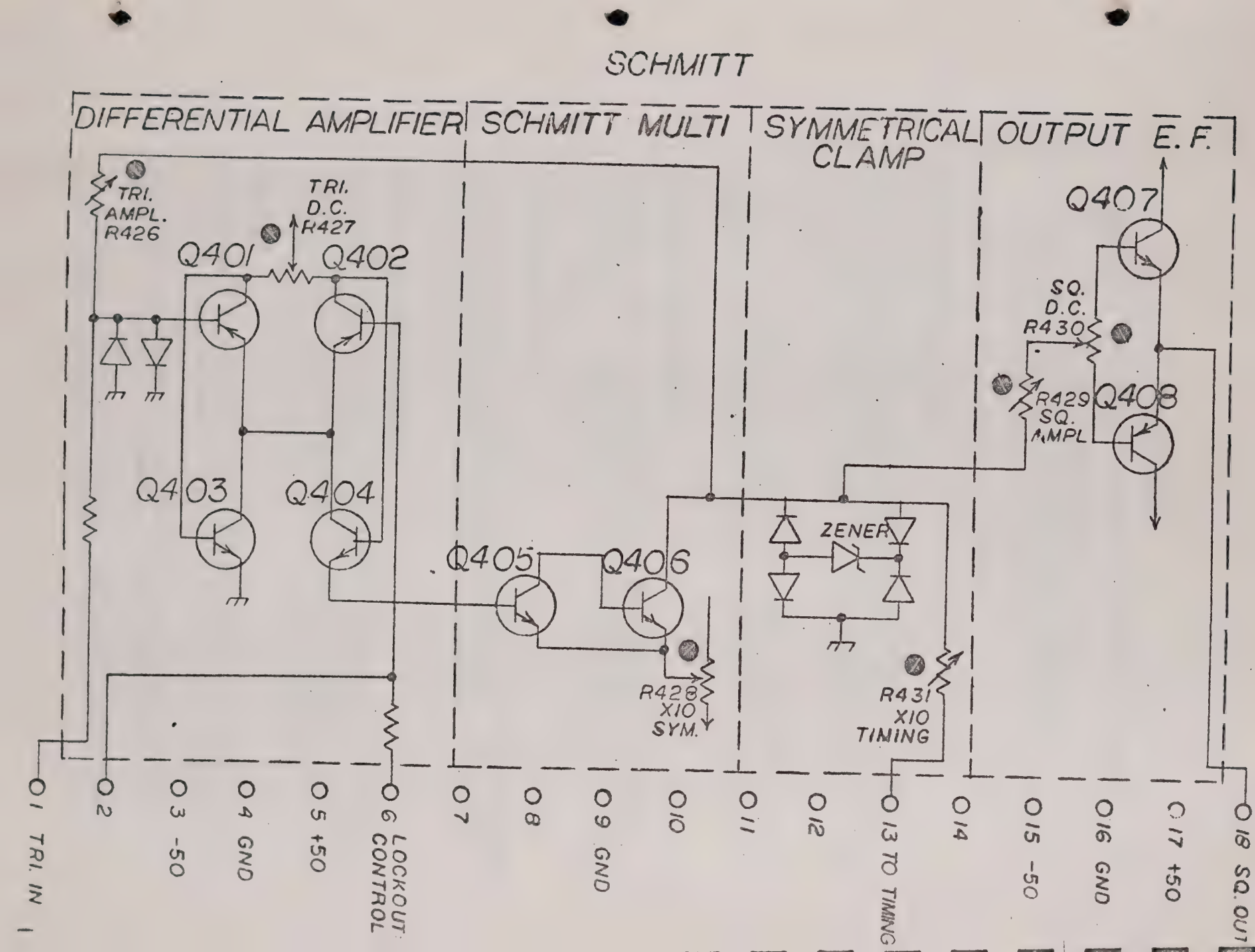
LOCKOUT AMPLIFIER

Q510/Q511 drive Q508-Q509 at a low impedance. During Normal run, Q508-Q509 have no supply voltage. During lockout, the voltage to Q508-Q509 is supplied through pin 18. The signal from Q509 to the input of the operational amplifier through D501 causes lockout at the required voltage.

R528 (Tri. Lockout D.C.) sets the D.C. level at the output of the operational amplifier at zero volts with no external influence.

GENERAL

The Function Selector switch applies an off-setting D.C. voltage at pin 11 depending on the function selected; this establishes the level at which the triangle integrator will lock out.


SCHMITT
DIFFERENTIAL AMPLIFIER
SCHMITT MULTI
SYMMETRICAL CLAMP
OUTPUT E. F.
TRI. AMPL. R426
TRI. D.C. R427
Q401
Q402
Q403
Q404
Q405
Q406
Q407
Q408
SQ. D.C. R430
R429 SQ. AMPL
ZENER
R428 X10 SYM.
R431 X10 TIMING
O1 TRI. IN
O2
O3 -50
O4 GND
O5 +50
O6 LOCKOUT CONTROL
O7
O8
O9 GND
O10
O11
O12
O13 TO TIMING
O14
O15 -50
O16 GND
O17 +50
O18 SQ. OUT

SCHMITT

The Schmitt P.C. board generates the square waveform which

1. Drives the INTEGRATOR P.C. board
2. Drives timing resistors and capacitors.
3. Furnishes reset signal to GATE LOCKOUT board.
4. Furnishes auxiliary output.

Functionally it operates as follows:

DIFFERENTIAL AMPLIFIER

D401-D402 limit the signal amplitude applied to Q401. Q401-Q402 form a differential amplifier which sets the level and provides gain on the input triangle. Q403-Q404 are an emitter follower pair which temperature compensate the signal fed to Q405-Q406.

R426 (Tri. Ampl. Adj.) and R401 control the mixture of square and triangle applied to the differential amplifier. R427 (Tri. D.C. Adj.) balances Q401-Q402 for proper D.C. level.

SCHMITT MULTIVIBRATOR

Q405-Q406 form a Schmitt multi which produces a square waveform to the symmetrical clamp by switching at the triangle peaks. R428 (X10 Sym.) balances + and - excursions of the square waveform.

SYMMETRICAL CLAMP

The diode network limits the excursions of the square waveform (determined by the Zener) to Q407-Q408. R431 (X10 Timing) adjusts amplitude of square waveform to timing potentiometer.

OUTPUT EMITTER FOLLOWER

Q407/Q408 are complementary emitter followers delivering a low impedance square waveform to auxiliary output. R429 (Sq. Ampl.) adjusts amplitude of output square wave. R430 (Sq. D.C.) adjusts output D.C. level of square wave.

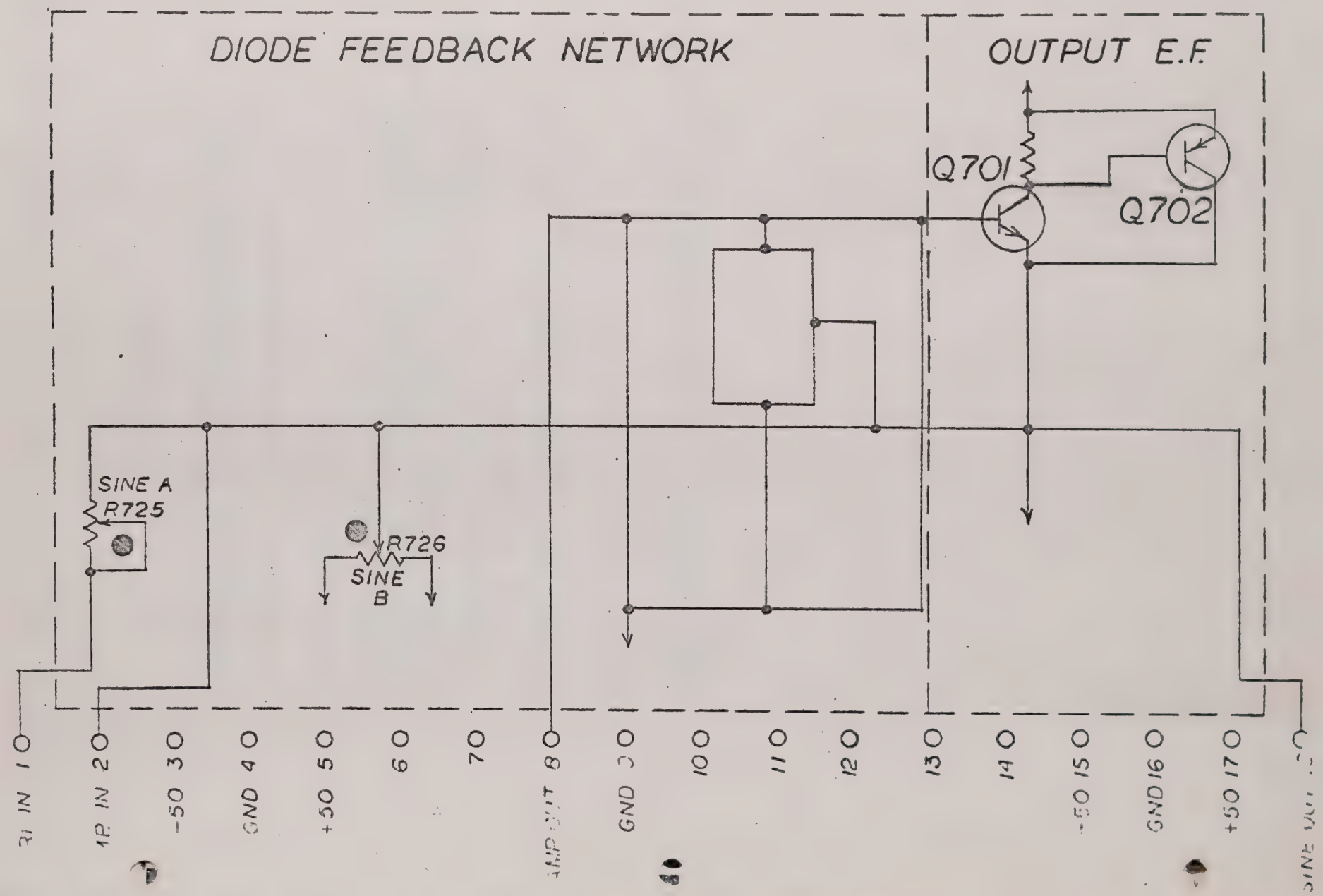
GENERAL

In TRIGGER or CONTROL mode, the square wave at pin 18 furnishes a reset signal to the GATE LOCKOUT P.C. board.

The D.C. level applied at pin 6 during lockout shifts the Schmitt trip point to provide stable haver-function.

In RAMP HOLD function settings, the reset switch supplies a reset signal at pin 2 to flip the Schmitt.

SIN. SHAPER


DIODE FEEDBACK NETWORK
OUTPUT E.F.
Q701
Q702
SINE A
R725
R726
SINE
B
1P IN 20
-50 30
GND 40
+50 50
60
70
GND 90
100
110
120
130
140
-50 150
GND 160
+50 170

SINE SHAPER

The Sine Shaper P.C. board generates a sine waveform which furnishes auxiliary sine output.

Functionally, it operates as follows:

DIODE FEEDBACK NETWORK

The Diode Feedback Network in conjunction with the Sine Amplifier P.C. board incrementally reduces the gain of the triangle waveform as its output rises and falls, thereby shaping a sine wave.

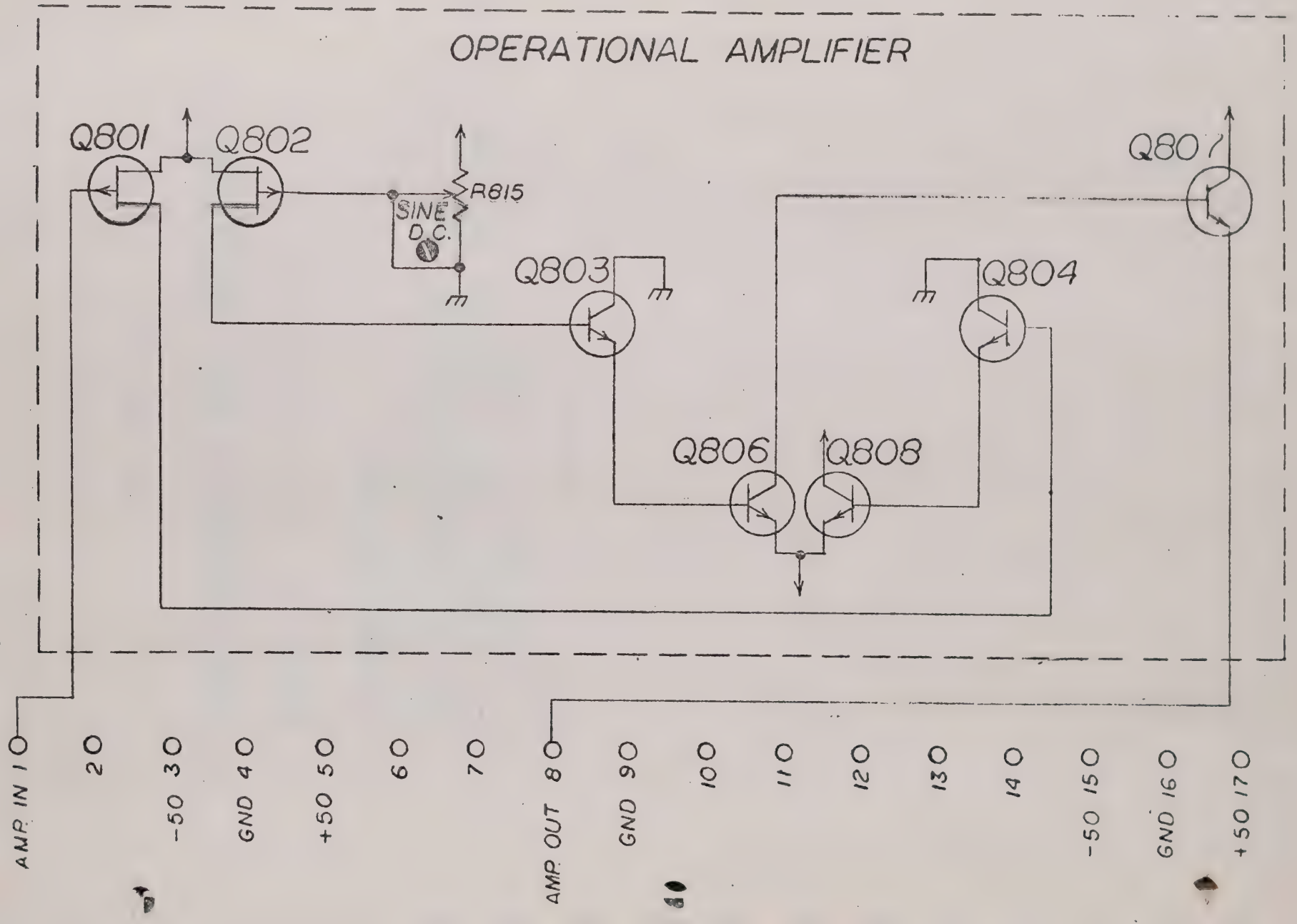
R725 (Sine A) adjusts the amount of signal applied to the amplifier input.

R726 (Sine B) injects a small D.C. offset voltage to correct triangle D.C. level errors.

OUTPUT EMITTER FOLLOWER

Q701-Q702 form an output emitter follower which provides a moderately low output impedance to the auxiliary output.

SINE AMPLIFIER



SINE AMPLIFIER

The Sine Amplifier P.C. board provides amplification to the Sine Shaper P.C. board. The two boards work in conjunction to generate the sine waveform.

Functionally, the Sine Amplifier board operates as follows:

OPERATIONAL AMPLIFIER

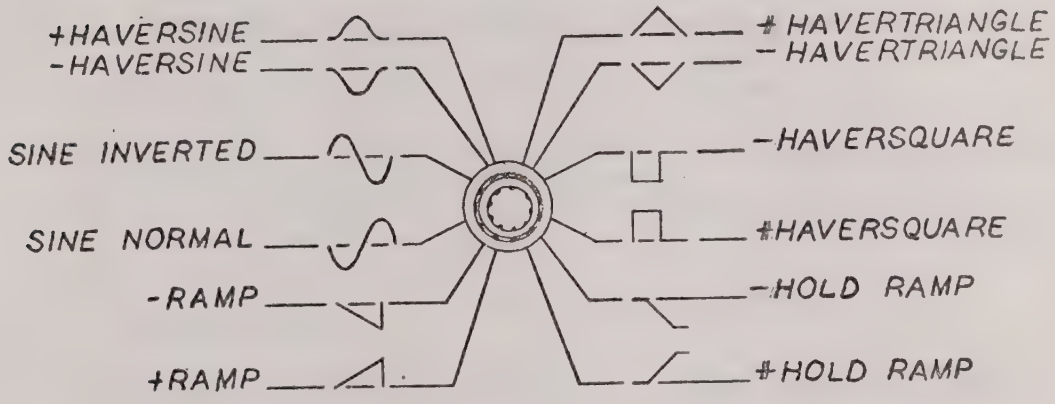
Q801-Q807 form a high-gain, high-stability operational amplifier to perform high accuracy computation of the sine waveform from the triangle in conjunction with the Sine Shaper P.C. board. The output through pin 8 supplies a low impedance source to drive the diode feedback network on the Sine Shaper P.C. board.

R815 (Sine D.C.) balances Q801-Q802.

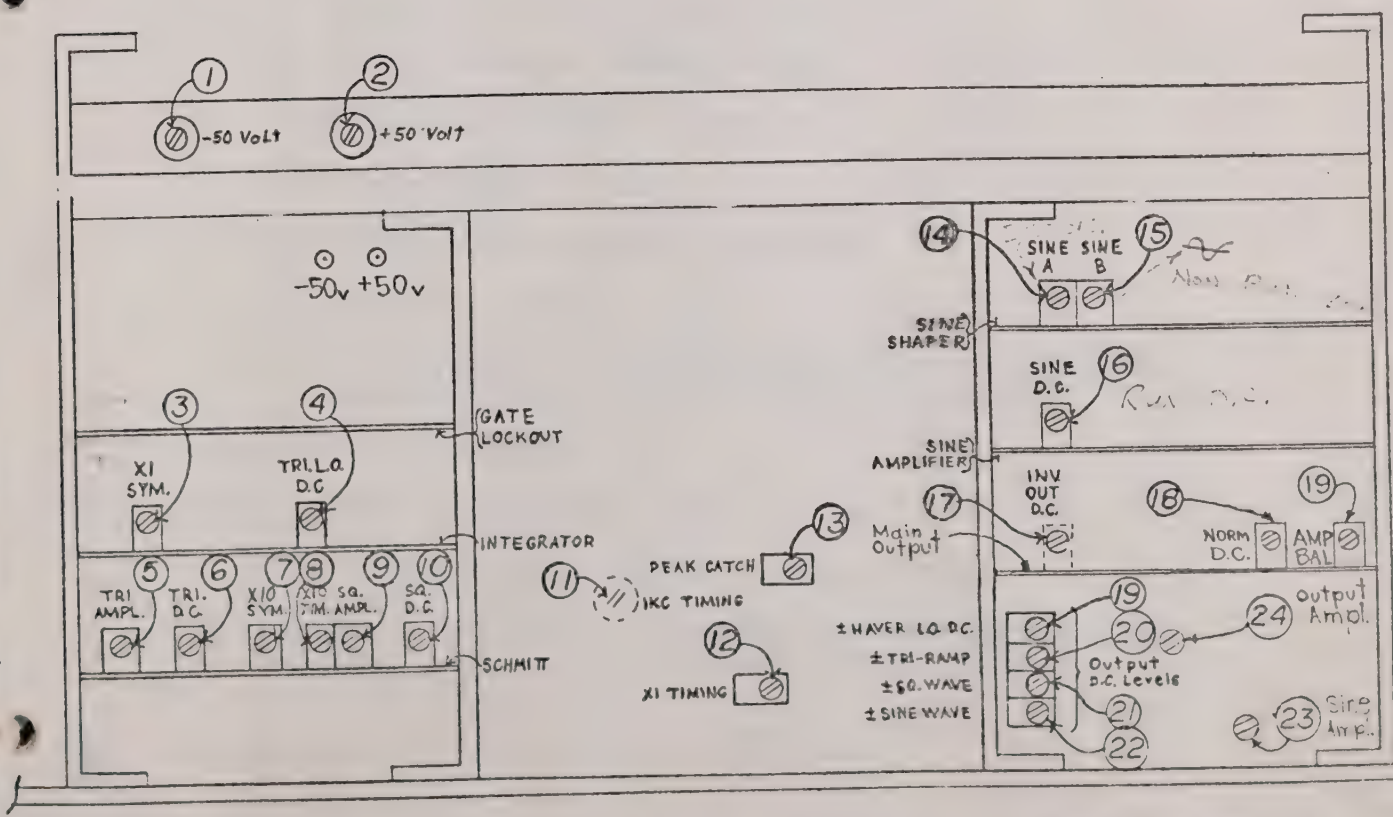
SECTION 4 CALIBRATION

OPERATOR ADJUSTMENT PROCEDURE

THE FOLLOWING ADJUSTMENT PROCEDURE SHOULD BE USED WHEN AN INSTRUMENT IS FIRST INSTALLED IN A SYSTEM. IT IS OFTEN NECESSARY TO CHANGE THE OUTPUT AMPLITUDES AND D.C. LEVELS. WHENEVER THE UNIT IS USED TO DRIVE LOADS DIFFERENT THAN THOSE USED DURING CALIBRATION AT THE FACTORY.



FUNCTION SWITCH



ADJUSTMENT LOCATION DETAIL (TOP VIEW)

4.1.0 PRELIMINARY REQUIREMENTS BEFORE STARTING CALIBRATION

1. Before any attempt is made to calibrate the instrument, be sure all P.C. boards are in place and all output and gating functions work properly.

2. A 30-minute warm-up time is required with covers in place before attempting calibration.

3. Equipment required for calibration

   A. Tektronix oscilloscope Type 544 or equivalent

   B. Tektronix plug-in Type W or equivalent

   C. Variac Type EICO 107B or equivalent

   D. Universal counter-timer, Computer Measurements Company Model CMC 607A or equivalent

   E. Sine distortion analyzer, Hewlett Packard Type 333A or equivalent

   F. Differential voltmeter, Medistor Type A-75 or equivalent.

4. Front panel control positions (unless otherwise noted) for each step

   A. Function Switch - Sine Normal

   B. Run Disconnect Switch - Run

   C. Multiplier Switch - 10/110

   D. Timing Dial - 10.0

   E. Control Mode Switch - Free Run

   F. Hold Run Switch - Run

   G. For numbers in parentheses, refer to Adjustment Location Detail for adjustment location.

4.2.0 CALIBRATION PROCEDURE

4.2.1 POWER SUPPLY ADJUSTMENTS, ±50V

A. Place Control Mode switch to Manual Trig.

B. Connect differential voltmeter to +50V supply test point in left hand mother board (see adjustment location detail).

C. Adjust +50V Adj (1) for +50V ±5mv.

4.2.1 POWER SUPPLY ADJUSTMENTS ±50V (continued)

D. Connect differential voltmeter to -50V supply test point on left hand mother board (see adjustment location detail).

E. Adjust -50V Adj (2) for -50V ±5mv.

F. Using oscilloscope, test the + and - 50V test points for A.C. ripple of less than 5mv.

G. Vary input line voltage from 105V to 125V and check to see that the + and - 50V supplies regulate within 10mv

4.2.2 X10 SYMMETRY ADJUSTMENT

A. Place Control Mode to Free Run.

B. Probe the collector of Q406 on Schmitt plug-in board; should see approximately ±16V square wave. (32 P/P)

C. Adjust X10 Sym (7), matching the ±excursions to within 10mv of each other.

4.2.3 X1 SYMMETRY ADJUSTMENT

A. Probe pin 1 of Integrator board.

B. Adjust X1 Sym (3) for 0 V ±20mv.

4.2.4 TRIANGLE AMPLITUDE AND D.C. LEVEL ADJUSTMENT

A. Probe triangle front panel auxiliary jack.

B. Adjust Triangle Amp Adj (5) to 26.2V P-P ±40mv.

C. Adjust Triangle D.C. Level Adj (6) for 0V D.C. level ±20mv.

4.2.5 SQUARE AMPLITUDE AND D.C. LEVEL ADJUSTMENT

A. Probe square front panel auxiliary jack.

B. Adjust Square Amp Adj (9) to 26.2V ±40mv.

C. Adjust Square D.C. Adj (10) for 0V D.C. level ±20mv.

4.2.6 LOCKOUT D.C. LEVEL ADJUSTMENT

A. Place Control Mode switch to Manual Trig.

B. Probe Triangle front panel auxiliary jack.

C. Adjust Tri L.O. D.C. (4) for 0V ±20mv.

4.2.7 ±HAVER LEVEL ADJUSTMENT

A. Place Function switch to -Haversine.

B. Place Control Mode switch to Manual Trig.

C. Probe triangle front panel auxiliary jack.

D. Adjust ±Haver L.O. D.C. (19) for 13.1V ±20mv.

4.2.8 CHECK CONTROL MODE FUNCTIONS

A. Place Control Mode switch to Manual Trig.

B. Probe Triangle auxiliary jack.

C. Check for one cycle of operation each time manual trig button is pushed (no adjustment).

D. Place Control Mode switch to Control Panel Run.

D. Connect the oscilloscope amplitude calibrator to the Gate In on rear panel.

F. Check to see if instrument runs with 5V applied from calibrator and turns off with 2V applied (no adjustment).

4.2.9 SINE D.C. LEVEL AND DISTORTION ADJUSTMENTS

A. Probe Sine front panel auxiliary jack.

B. Adjust Sine D.C. Level (16) for 0V D.C. level.

C. Place Control Mode switch to Manual Trig.

D. Adjust Sine B Adj (15) for 0V D.C.

E. Repeat steps B, C, and D until both conditions are met.

F. Place Control Mode to Free Run.

G. Connect sine distortion analyzer to Sine front panel auxiliary jack.

H. Adjust Sine A (14) for minimum distortion, <.5%.

4.2.10 MAIN OUTPUT D.C. BALANCE ADJUSTMENTS

A. Place two 500-ohm 1% 1/2W resistors from main out and inverted out to ground on strip on rear panel.

B. Probe front panel Main Output jack.

C. Place a jumper from pin 1 to pin 18 of main output board.

4.2.10 MAIN OUTPUT D.C. BALANCE ADJUSTMENTS (continued)

D. Place Function switch to Sine Inverted.

E. Adjust Inv. Out D.C. Adj (17) for 0V D.C.

F. Place Function switch to Sine Normal.

G. Adjust Norm D.C. Adj (18) for 0V D.C.

H. Remove jumper.

4.2.11 SQUARE AMPLITUDE AND D.C. LEVEL ADJUSTMENTS

A. Probe front panel Main output jack.

B. Place Function switch to -Haversquare.

C. Adjust Output Ampl Adj (24) for 10V peak ±50mv.

D. Adjust ±Sq Wave Adj (21) so that square starts at 0V ±20mv.

E. Repeat steps C & D until both conditions are met.

F. Place Function switch to +Haversquare.

G. Adjust Ampl Bal Adj (19) for a 10V peak squarewave ±50mv.

4.2.12 ±HAVERTRIANGLE D.C. LEVEL ADJUSTMENTS

A. Probe front panel Main output jack.

B. Place Function switch at +Havertriangle.

C. Adjust ±Tri Ramp Adj (20) so the negative peak of the triangle starts at 0V ±20mv.

D. Place Function switch at -Havertriangle and check to see if positive peak of triangle starts at 0V ±20mv.

E. Place Function switch at + and - Havertriangle and check to see if triangle amplitude is 10V ±10mv (no adjustment).

4.2.13 NORMAL AND INVERTED SINE ADJUSTMENTS

A. Probe front panel Main output jack.

B. Place Function switch to Sine Normal.

C. Adjust Sine Ampl Adj (23) for 20V P-P ±100mv.

D. Place Function switch to Sine Inverted.

4.2.13 NORMAL AND INVERTED SINE ADJUSTMENTS (continued)

E. Check for 20V P-P ±100mv (no adjustment).

F. Place Function switch to Sine Normal and Sine Inverted and check for 0V D.C. level ±20mv (if out of tolerance, recheck Step 4.2.9).

4.2.14 ±HAVERSINE D.C. LEVEL ADJUSTMENT

A. Probe front panel Main output jack.

B. Place Function switch in +Haversine.

C. Adjust ±Sine Wave Adj (22) so the negative peak of sine wave starts at 0V ±20mv.

D. Place Function switch in -Haversine and check to see if positive peak of the sine starts at 0V ±20mv (no adjustment).

E. Place Function switch in + and - Haversine positions and check to 10V peak ±100mv (no adjustment).

4.2.15 ±HAVER-RAMP CHECKS SAW TOOTH

A. Probe front panel Main output jack.

B. Place Function switch to +Haver-Ramp.

C. Check to see if Ramp is 10V peak ±100mv and negative peak starts at 0V ±20mv (no adjustment).

D. Place Function switch to -Haver-Ramp.

E. Check to see if Ramp is 10V peak ±100mv and positive peak starts at 0V ±20mv (no adjustment).

F. Check to see if ramp falltime is less than 10% at all frequencies (no adjustment).

G. Check to see if ramp frequency is twice the dial setting.

4.2.16 ±HOLD RAMP AMPLITUDE ADJUSTMENTS

A. Probe front panel Main output jack.

B. Place Function switch to -Hold Ramp.

C. Place Control Mode function switch to Manual Trigger.

D. Push Manual Trigger button and D.C. reference level should go to approximately -9.5V.

E. Adjust peak catch (13) for -9.5V ±20mv.

4.2.16 ±HOLD RAMP AMPLITUDE ADJUSTMENTS (continued)

F. Place Function switch to +Hold Ramp and check for +9.5V ±20mv.

G. Push reset button. Hold Ramp should return to zero.

H. Place Frequency Multiplier to .01 range and push Manual Trig button. Hold Ramp reference level should start to rise in positive direction. Before reference rises to 9.5V, switch Hold-Run switch to Hold and check reference level; should hold at that level (no adjustment).

4.2.17 TIMING ADJUSTMENTS

A. Connect Universal counter-timer to front panel Square auxiliary jack.

B. Place Frequency Multiplier switch to 10/110 and Timing dial to 10.0.

C. Adjust X10 Timing (8) for 100Hz ±2%.

D. Place Frequency Multiplier switch to 100/1100.

E. Adjust 1KC Timing (11) for 1000Hz ±2%.

F. Place Frequency Multiplier switch to 10/110 and Timing dial to 1.0.

G. Adjust X1 Timing (12) for 10Hz ±2%.

H. Check all frequency ranges of Multiplier switch for proper timing ±2% (no adjustment).

4.2.18 CHECK OPERATION OF RUN-DISCONNECT SWITCH

Place Run-Disconnect switch to Disconnect and check to see if Main output goes to zero volts. Check to see if Triangle at front panel Triangle auxiliary jack is running approximately ten times dial frequency.

4.2.19 REAR PANEL OUTPUT CHECKS

A. Check to see if Main output is the same as front panel Main output jack.

B. Check to see if Inverted output is 180° out of phase from Main output.

C. Check Trig out to see if square appears.

D. Check external timing pot connections for proper operation.

S E C T I O N 5 S C H E M A T I C S

Figure 1	Interboard Wiring
Figure 2	P.C. Assembly, Left Mother Board
Figure 3	P.C. Assembly, Right Mother Board
Figure 4	Assembly, Power Supply
Figure 5	P.C. Assembly, Schmitt
Figure 6	P.C. Assembly, Integrator
Figure 7	P.C. Assembly, Sine Shaper
Figure 8	P.C. Assembly, Sine Amplifier
Figure 9	P.C. Assembly, Gate Lockout
Figure 10	P.C. Assembly, Output Amplifier

SCHEMATICS

Figure 11	Power Supply
Figure 12	Gate Lockout
Figure 13	Sine Shaper
Figure 14	Sine Amplifier
Figure 15	Schmitt
Figure 16	Integrator
Figure 17	Output Amplifier
Figure 18	S60A-I Switch Detail

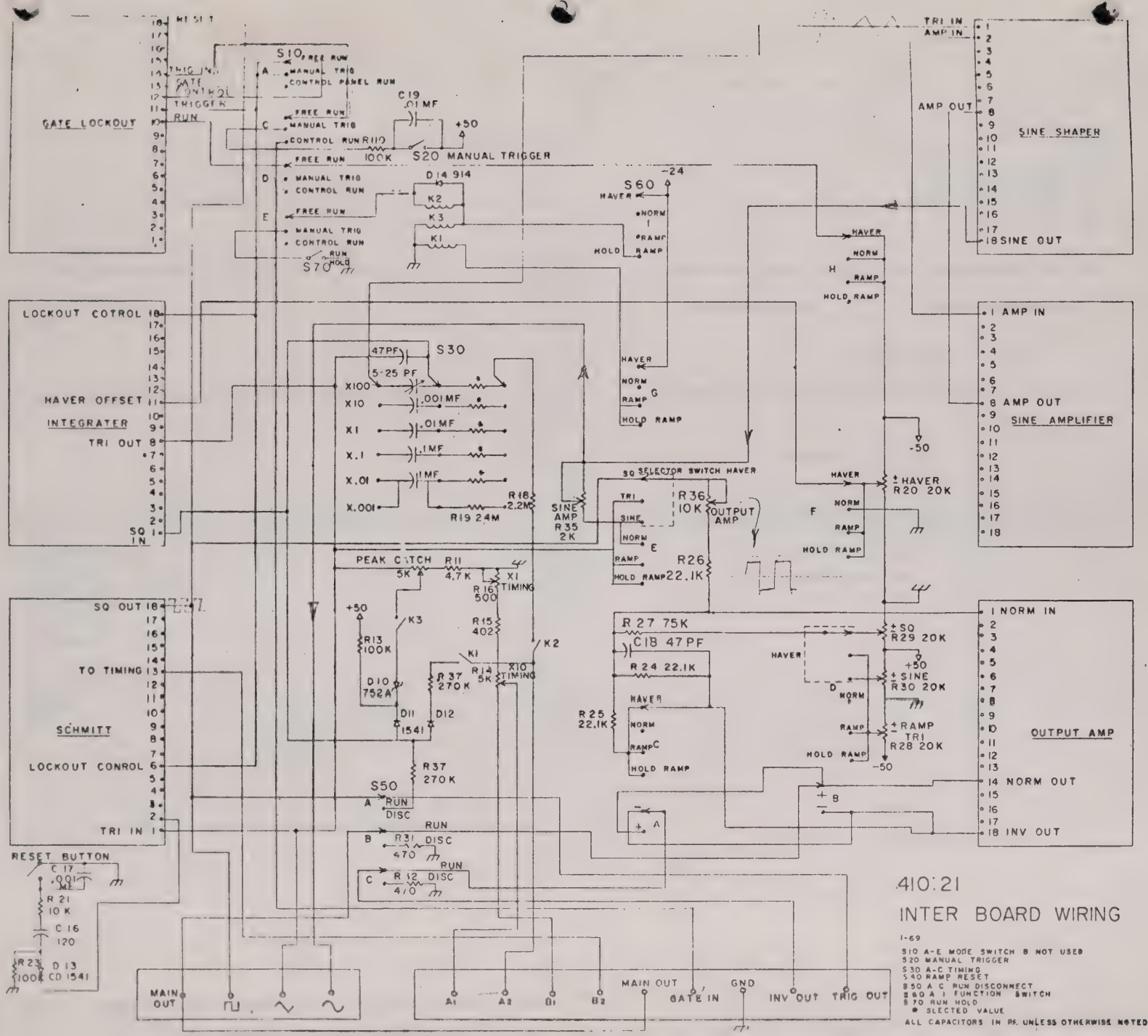


FIGURE 1

410:21

INTER BOARD WIRING

1-69

S10 A-E MODE SWITCH B NOT USED
S20 MANUAL TRIGGER
S30 A-C TIMING
S40 RAMP RESET
S50 A C RUN DISCONNECT
S60 A I FUNCTION SWITCH
S70 RUN HOLD
* SLECTED VALUE

ALL CAPACITORS IN PF. UNLESS OTHERWISE NOTED

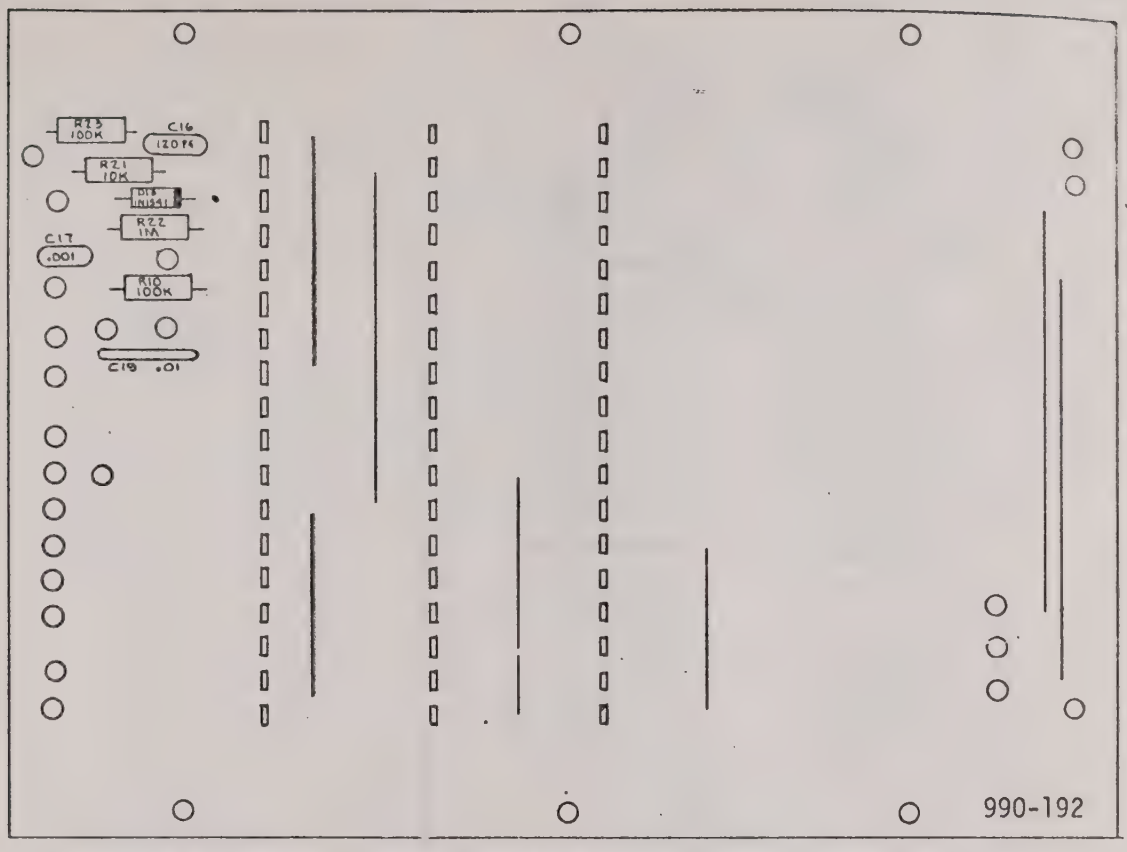


FIGURE 2 - PC ASSY - LEFT MOTHER BOARD 410:21

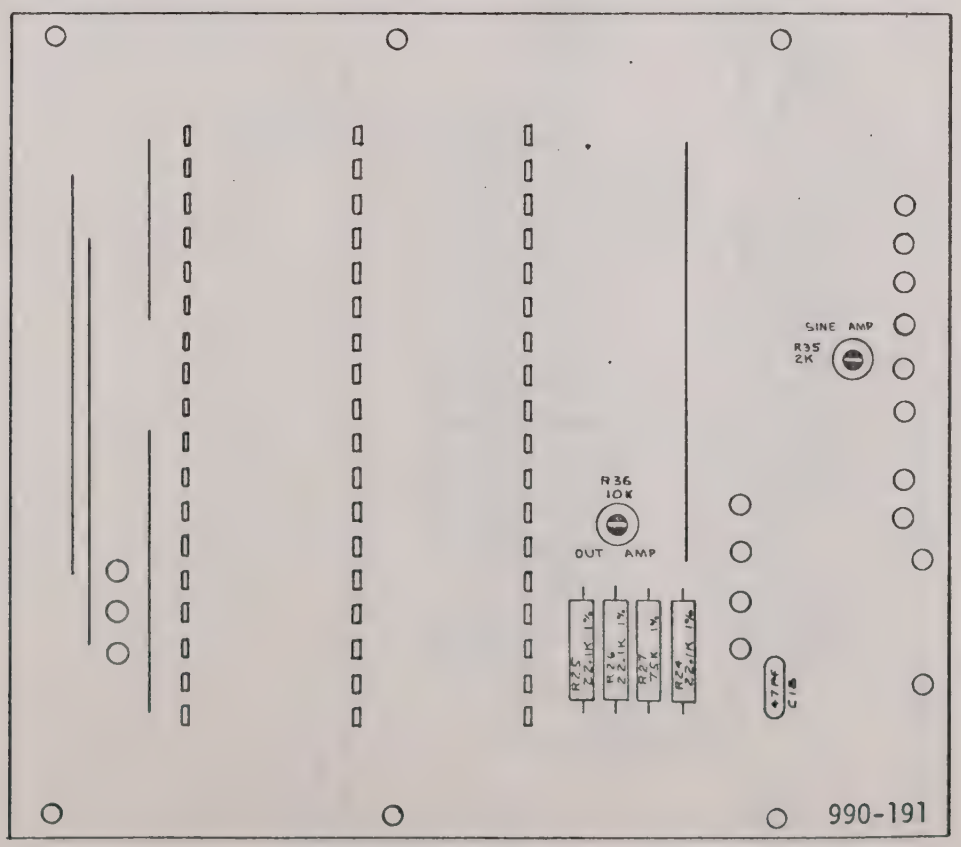


FIGURE 3 - PC ASSY - RIGHT MOTHER BOARD 410:21

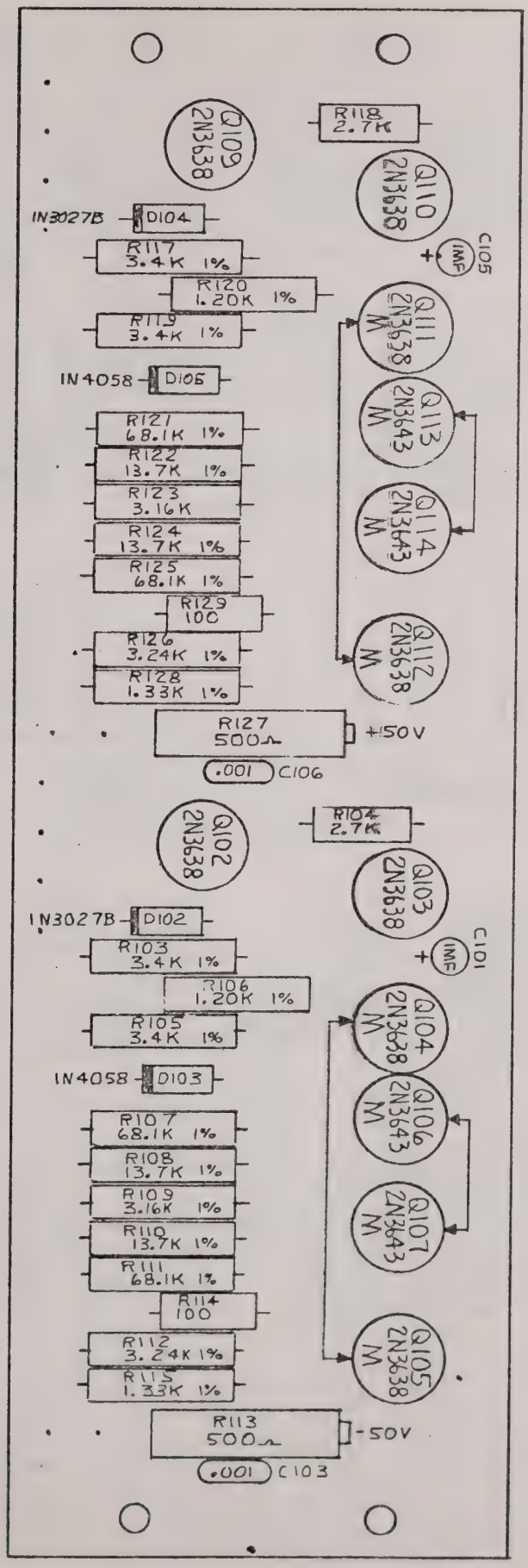


FIGURE 4

ASSEMBLY - POWER SUPPLY

410:21

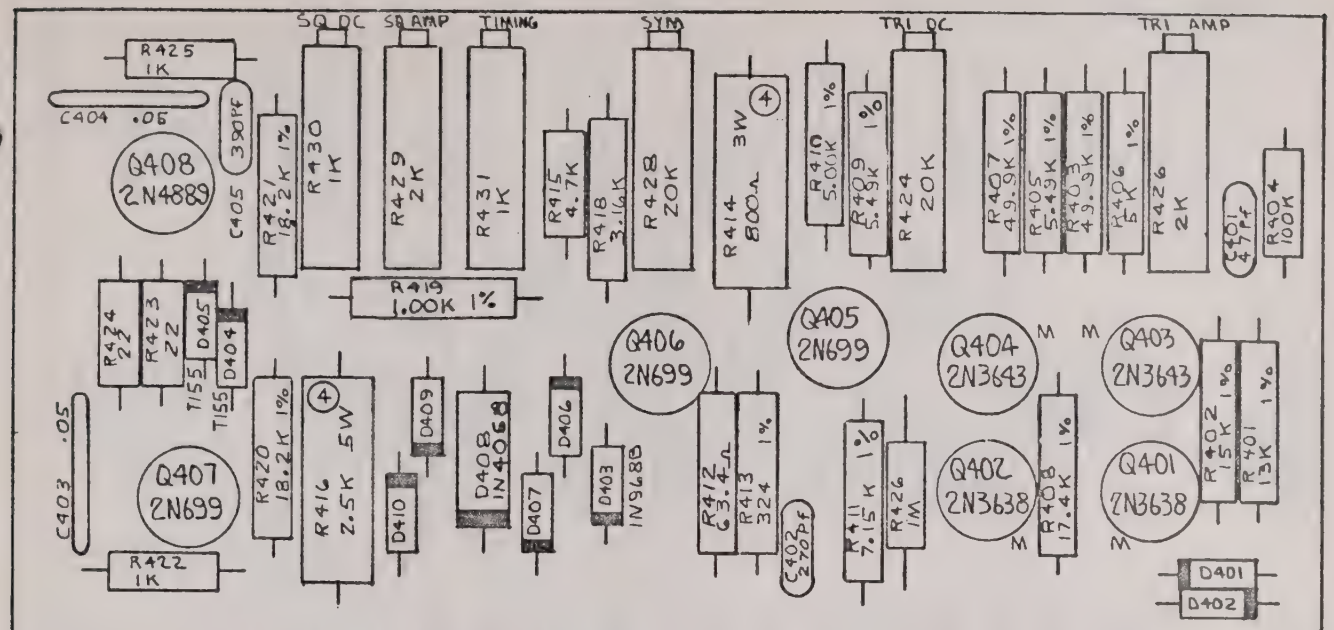


FIGURE 5

PC ASSY
SCHMITT
410:21

990-185

1. ALL RESISTORS MARKED IN OHMS
2. ALL CAPACITORS IN MFDs
3. M DENOTES MATCHED COMPONENTS
4. MOUNT WITH APPROX 1/8" CLEARANCE FROM BOARD

NOTES: UNLESS OTHERWISE INDICATED

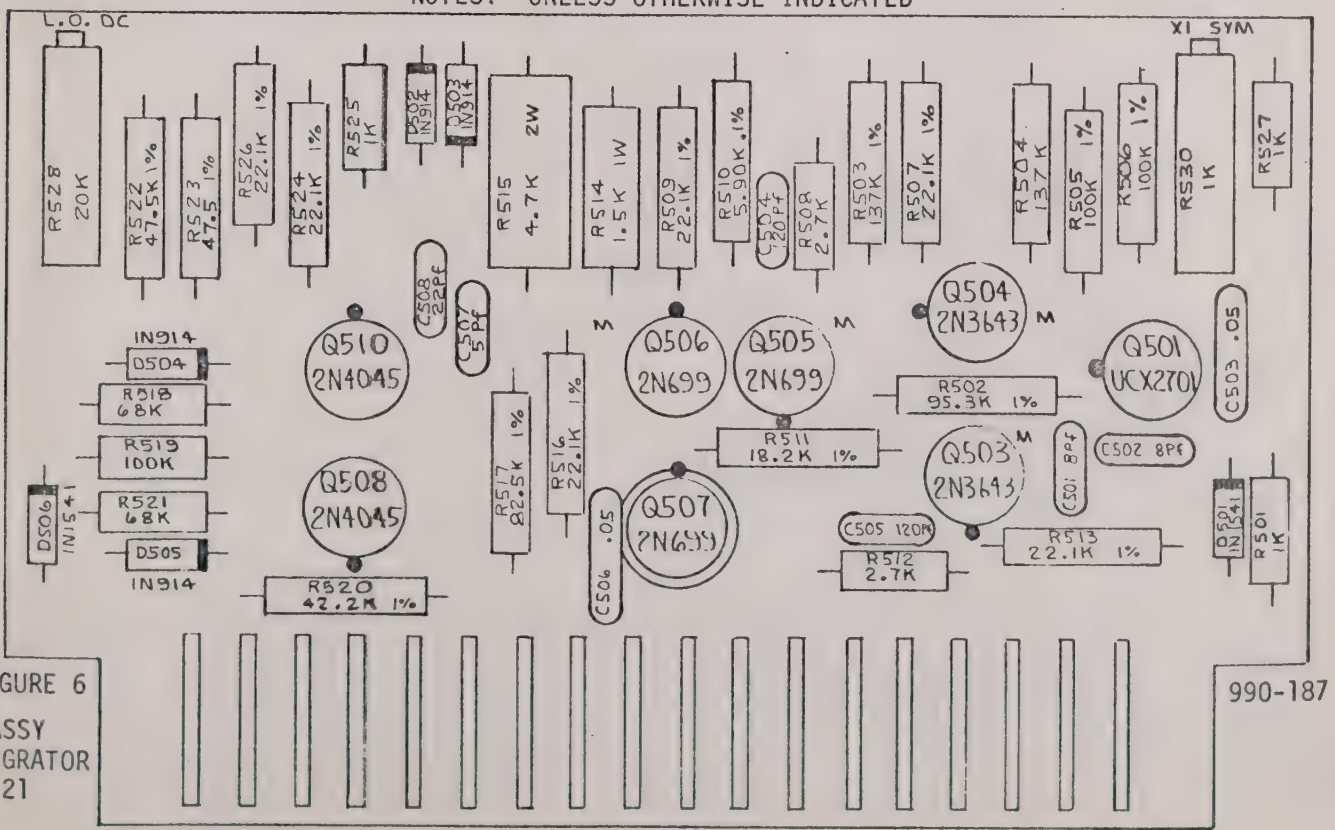


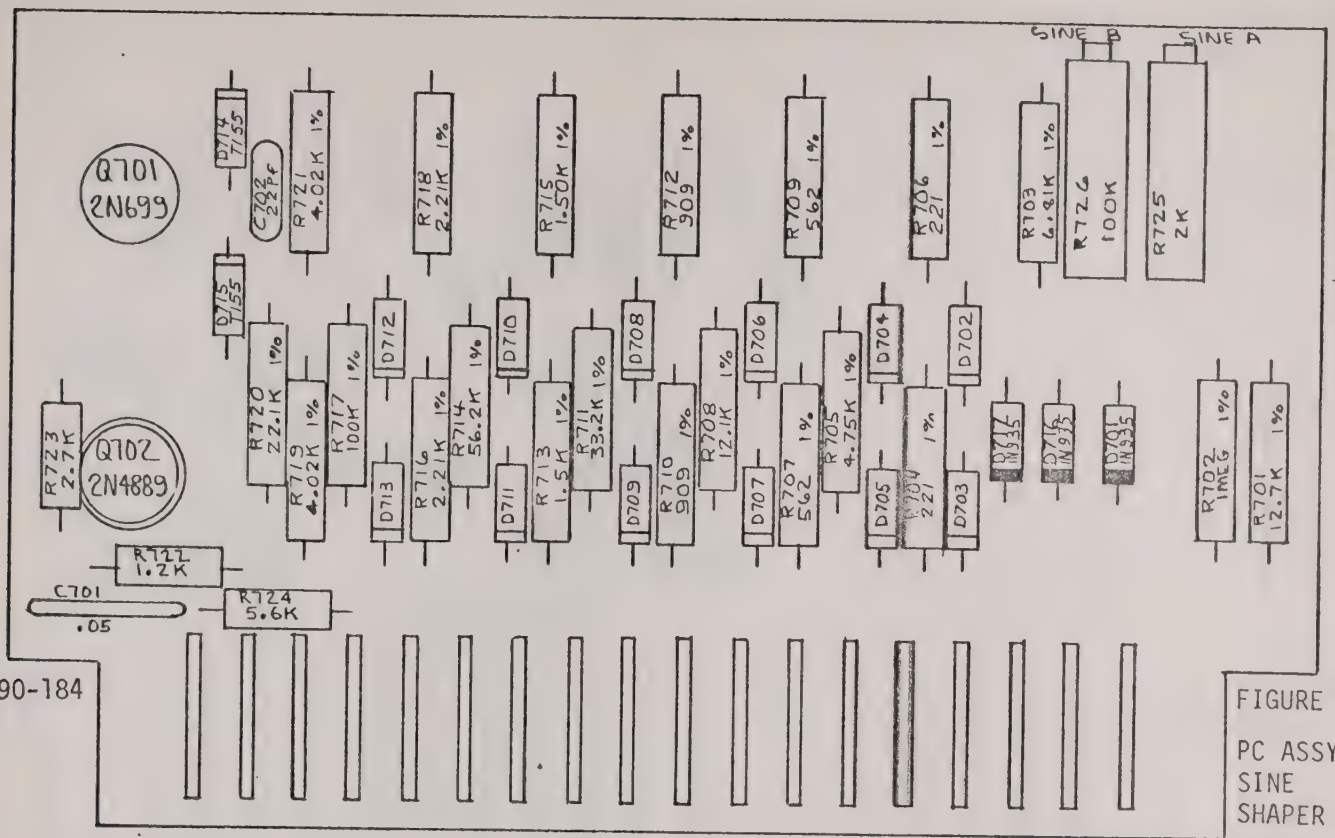
FIGURE 6

PC ASSY
INTEGRATOR
410:21

990-187

1. ALL RESISTORS MARKED IN OHMS
2. ALL CAPACITORS IN MFDs
3. M DENOTES MATCHED COMPONENT

NOTES: UNLESS OTHERWISE INDICATED



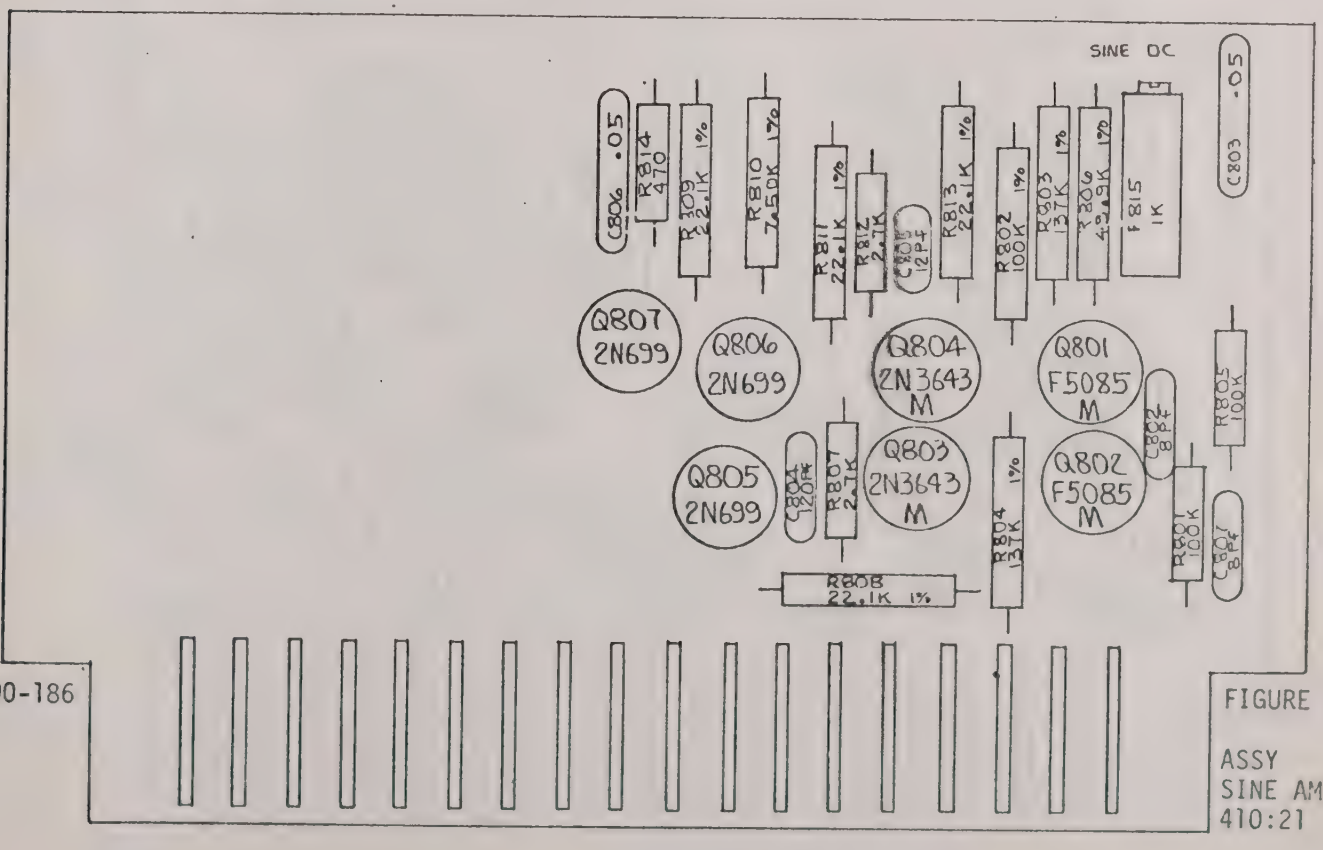
990-184

FIGURE 7

PC ASSY SINE SHAPER 410:21

1. ALL RESISTORS MARKED IN OHMS
2. ALL CAPACITORS IN MFDs

NOTES: UNLESS OTHERWISE INDICATED



990-186

FIGURE 8

ASSY SINE AMP 410:21

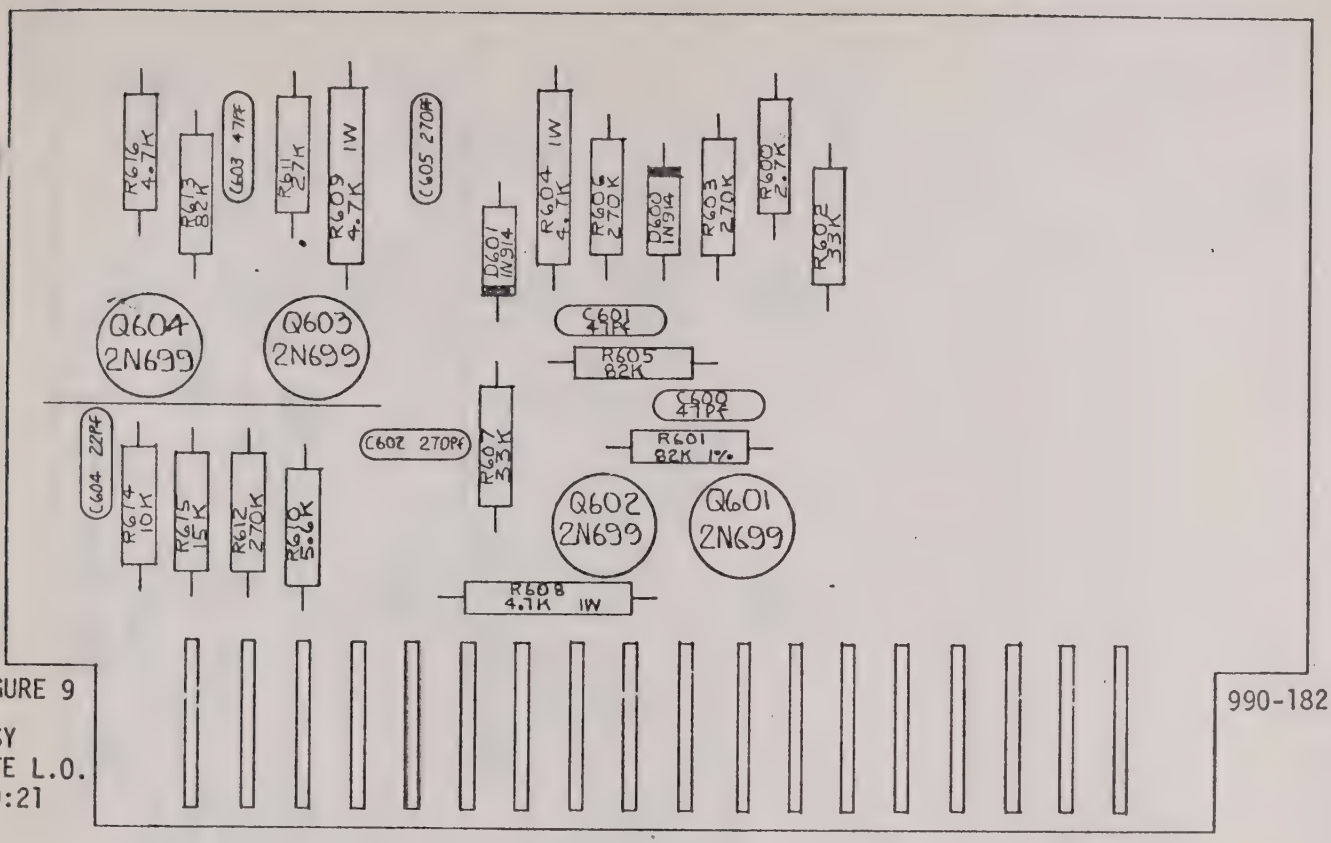


FIGURE 9

ASSY
GATE L.O.
410:21

990-182

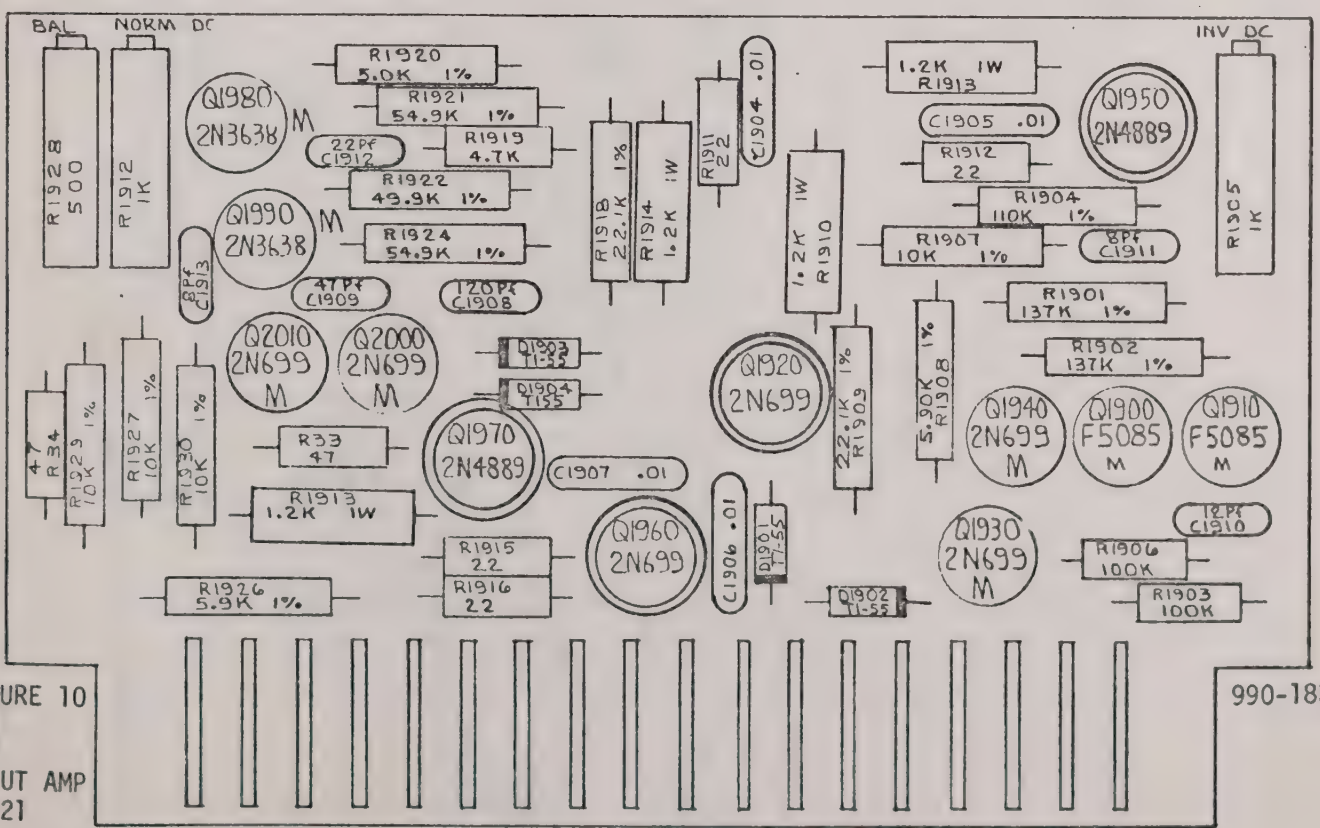


FIGURE 10

ASSY
OUTPUT AMP
410:21

990-183

1. ALL RESISTORS MARKED IN OHMS
2. ALL CAPACITORS IN MFDs

NOTES: UNLESS OTHERWISE INDICATED
3. M DENOTES MATCHED PAIR

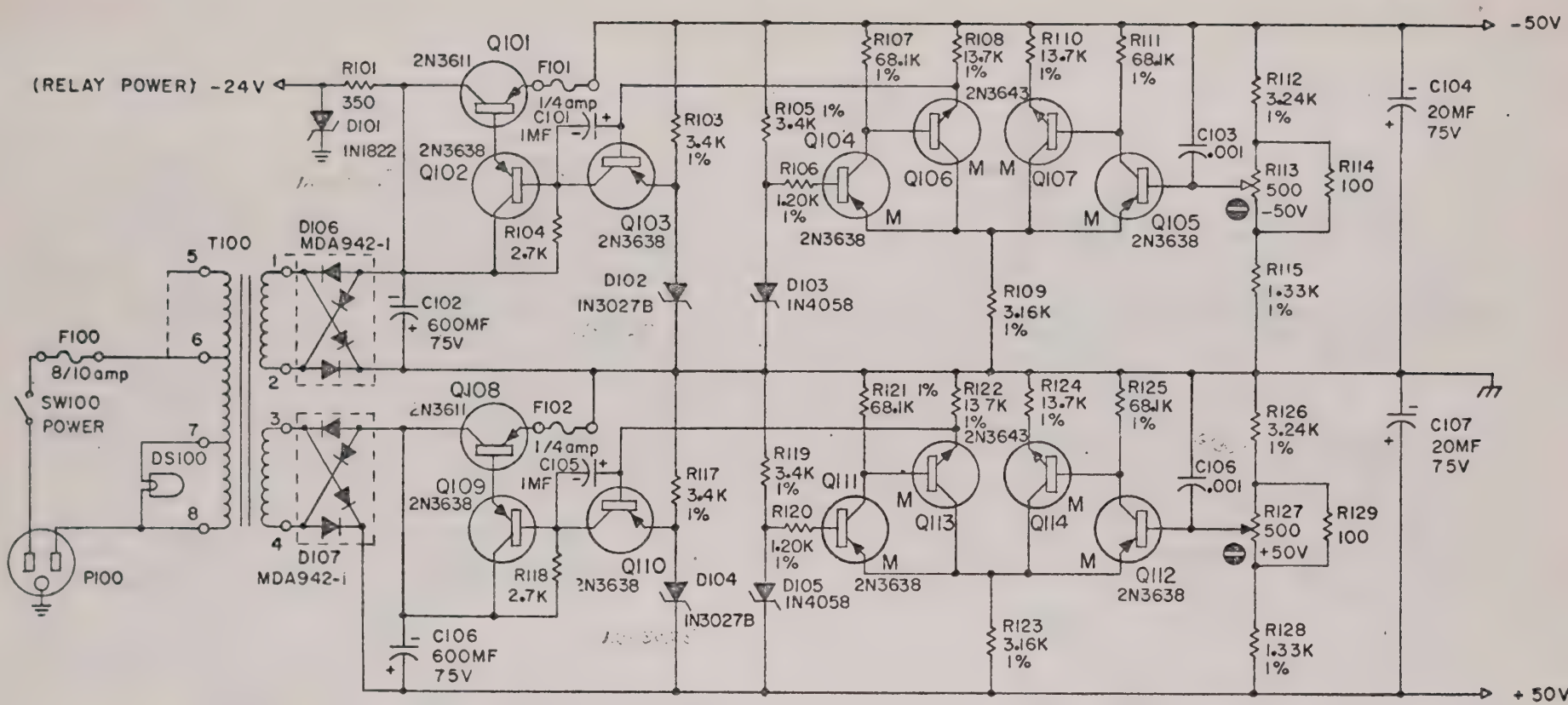


FIGURE 11

POWER SUPPLY
(410:21)

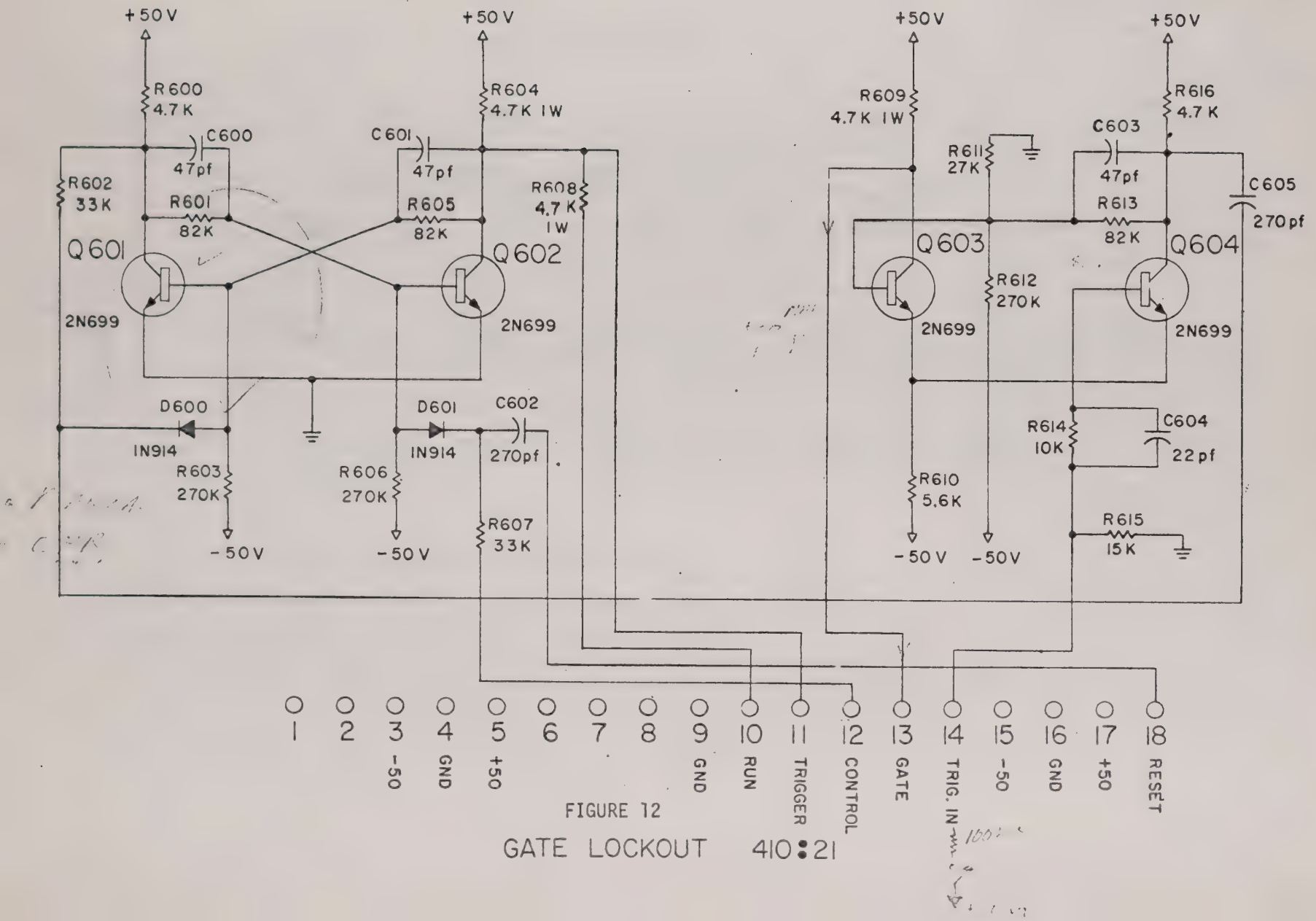


FIGURE 12

GATE LOCKOUT 410:21

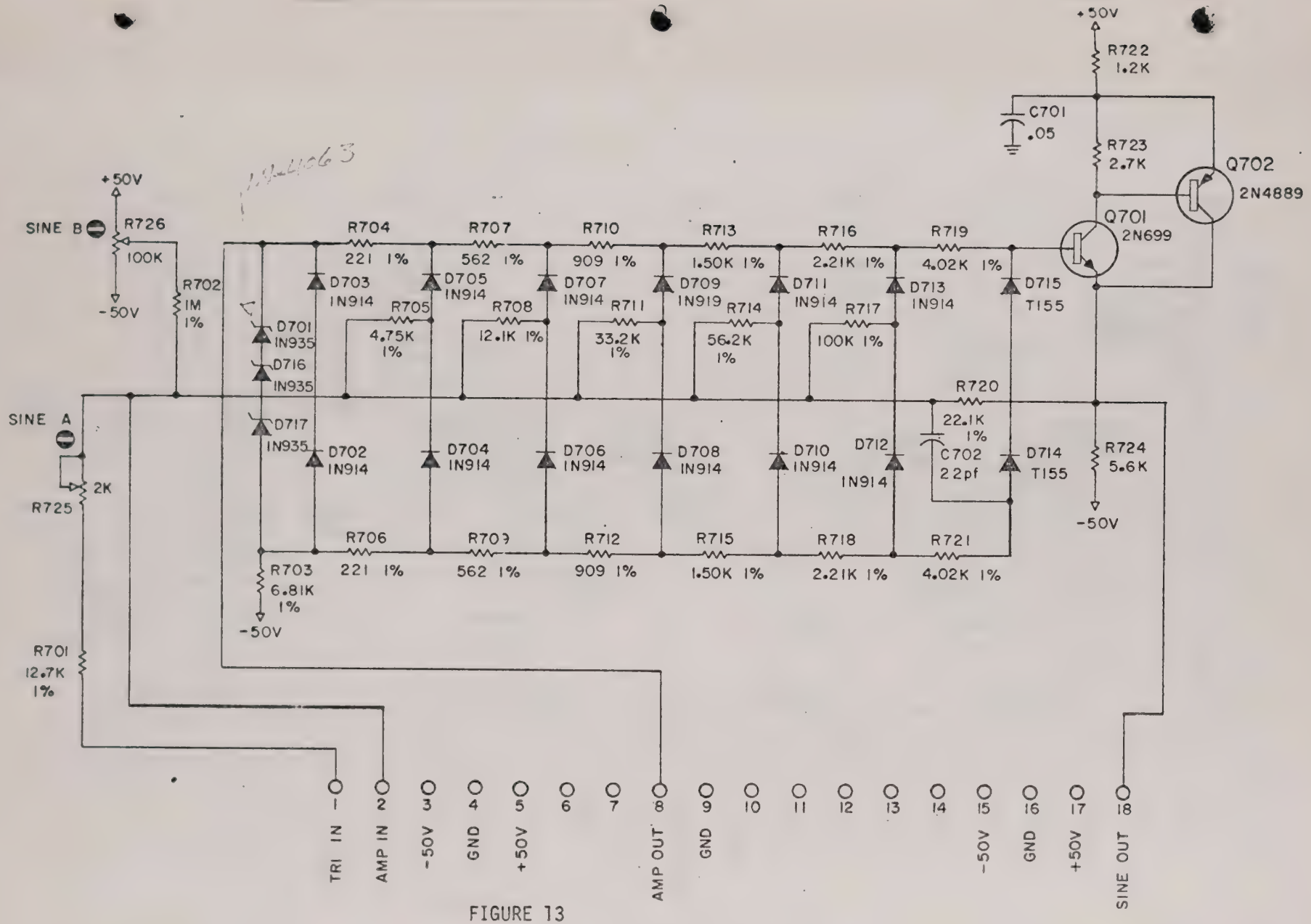


FIGURE 13

SINE SHAPER

(410:21)

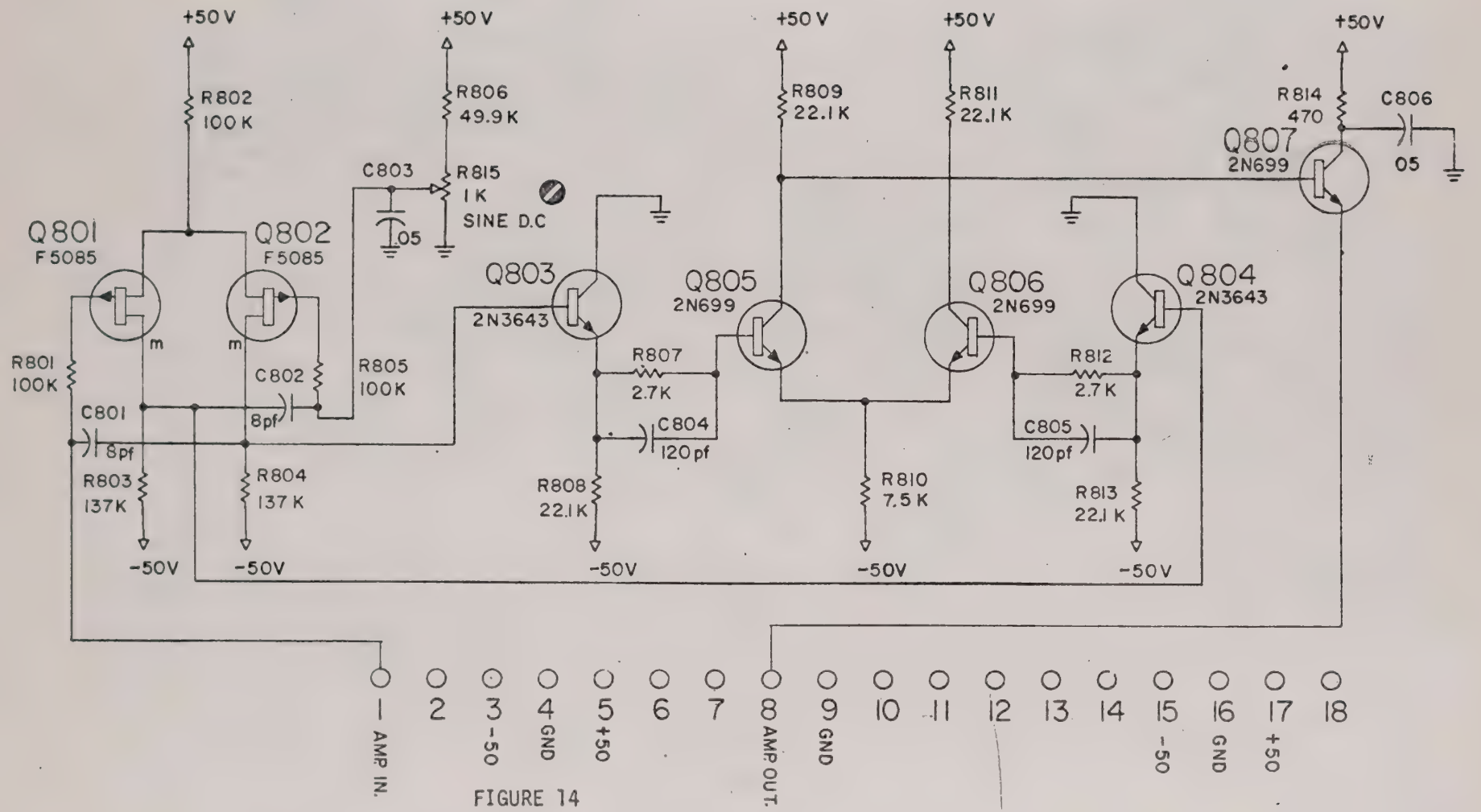


FIGURE 14

SINE AMPLIFIER 410:21

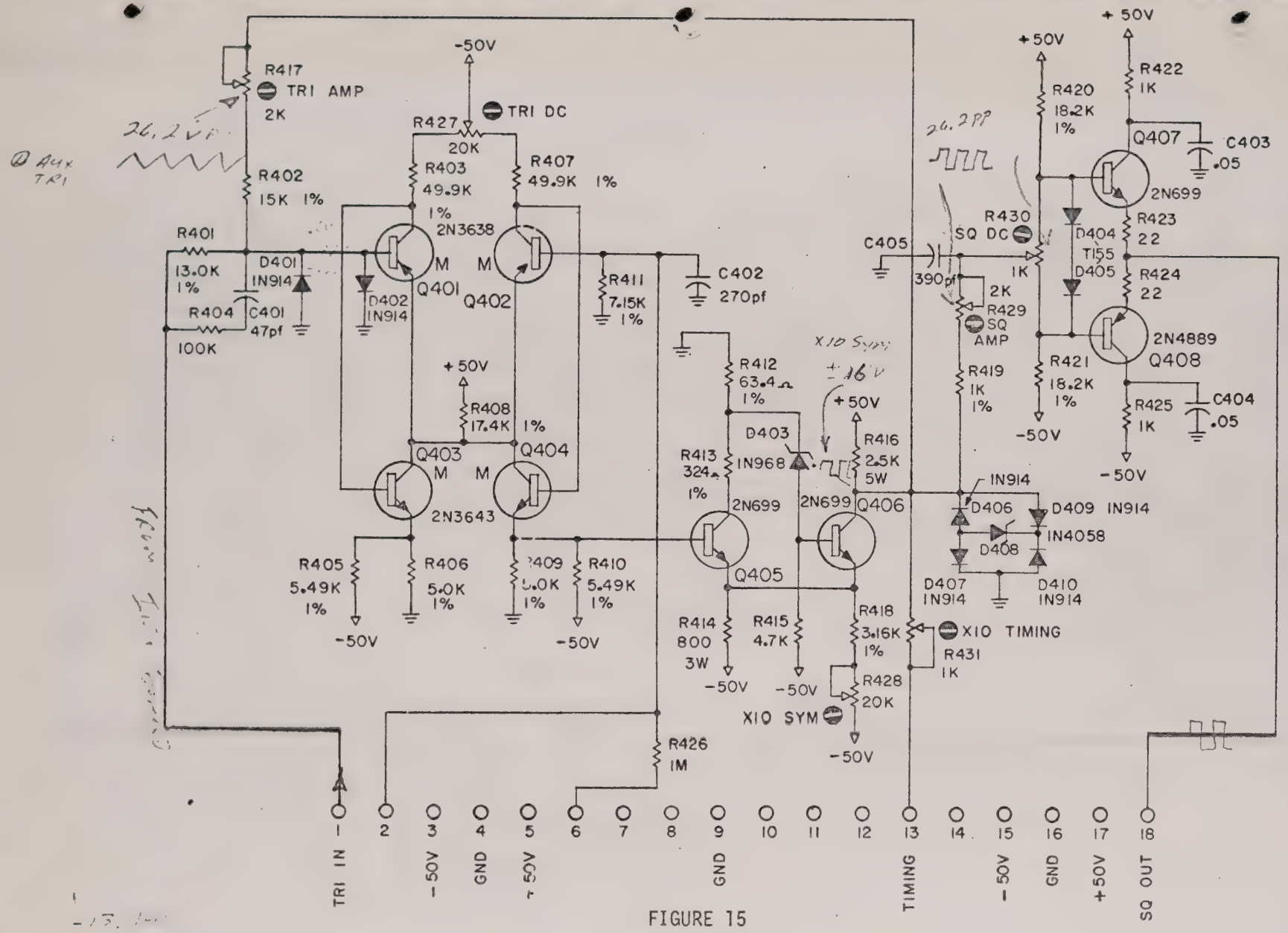


FIGURE 15

SCHMITT
(410 21)

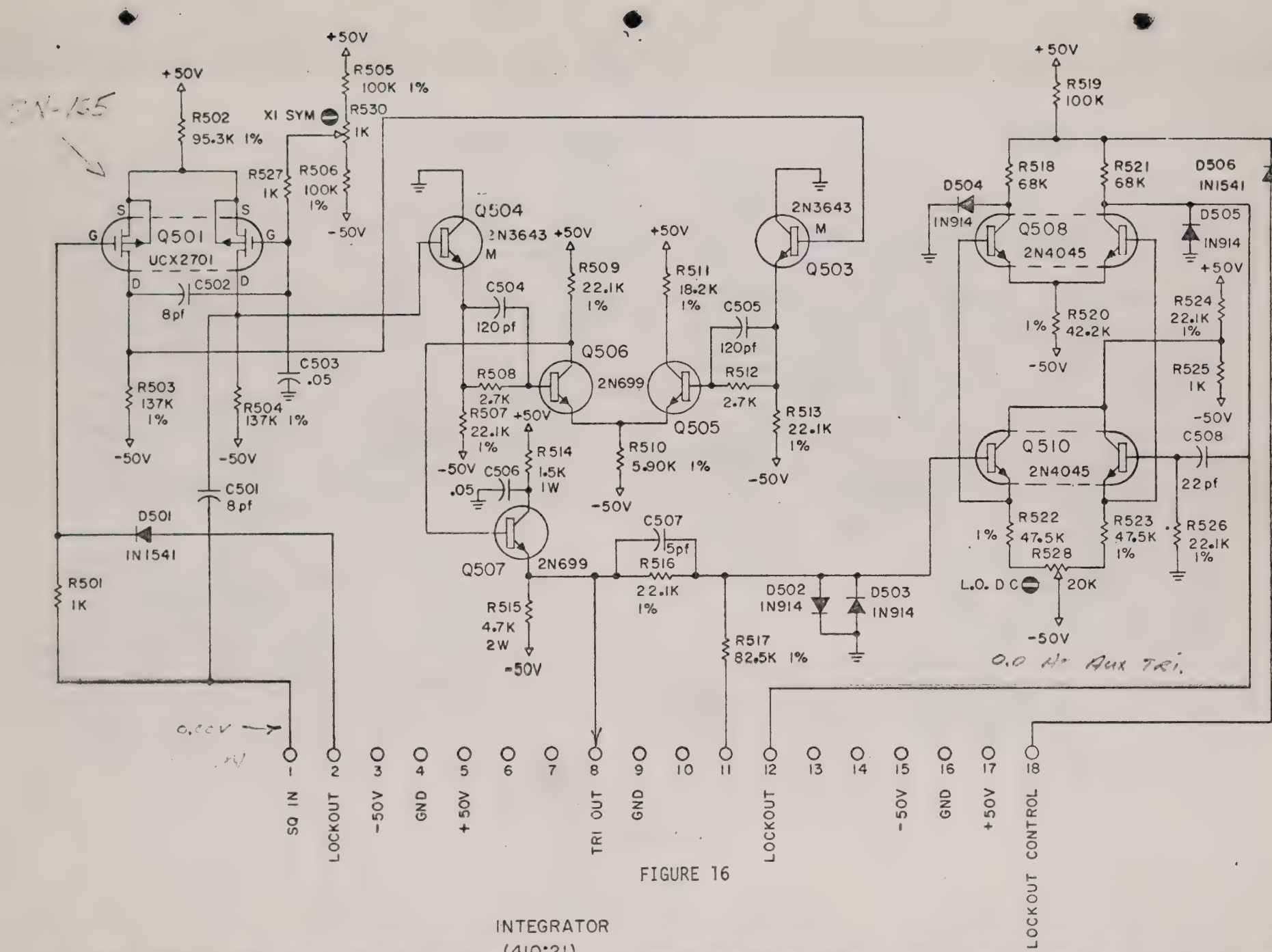


FIGURE 16

INTEGRATOR
(410:21)

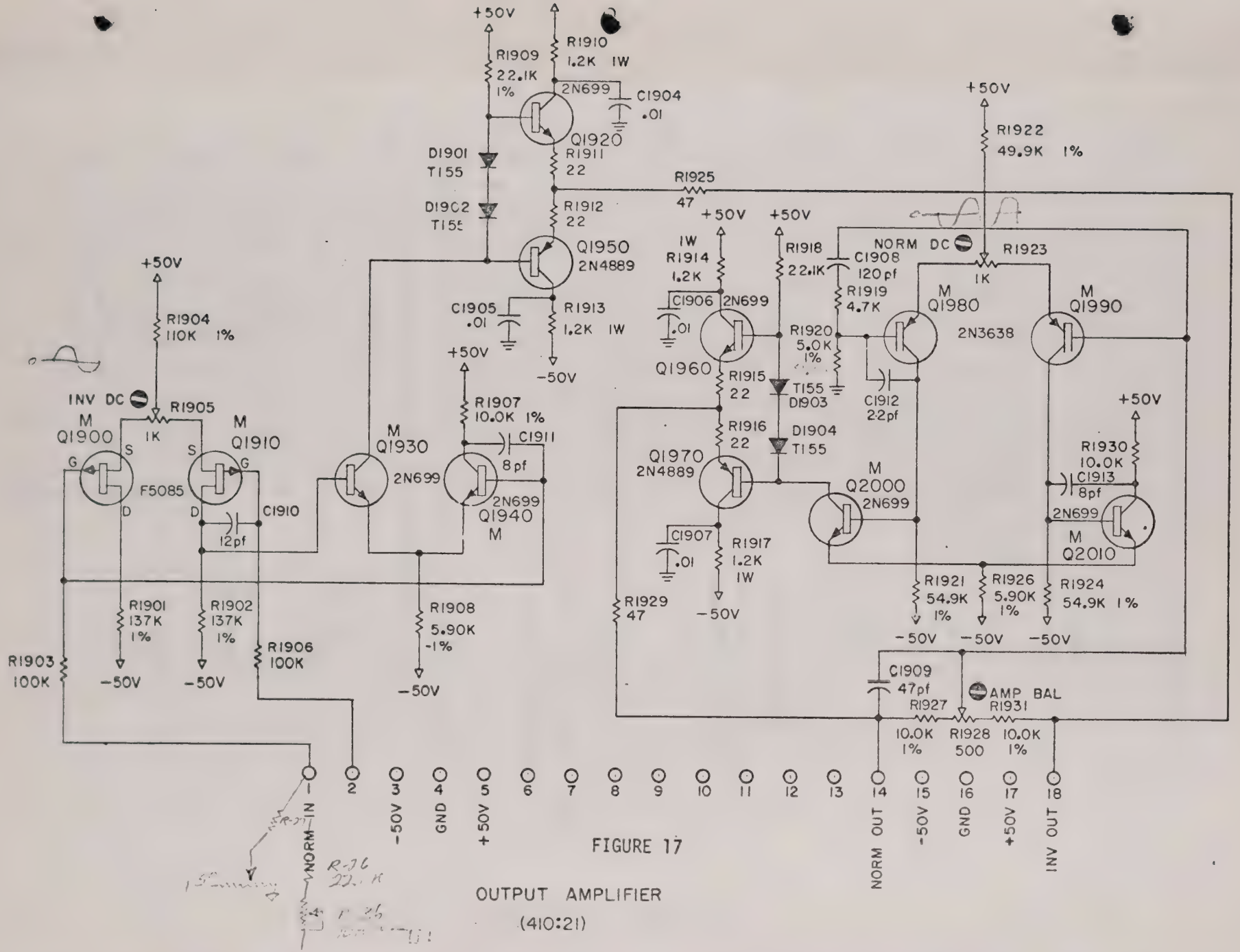


FIGURE 17

OUTPUT AMPLIFIER

(410:21)

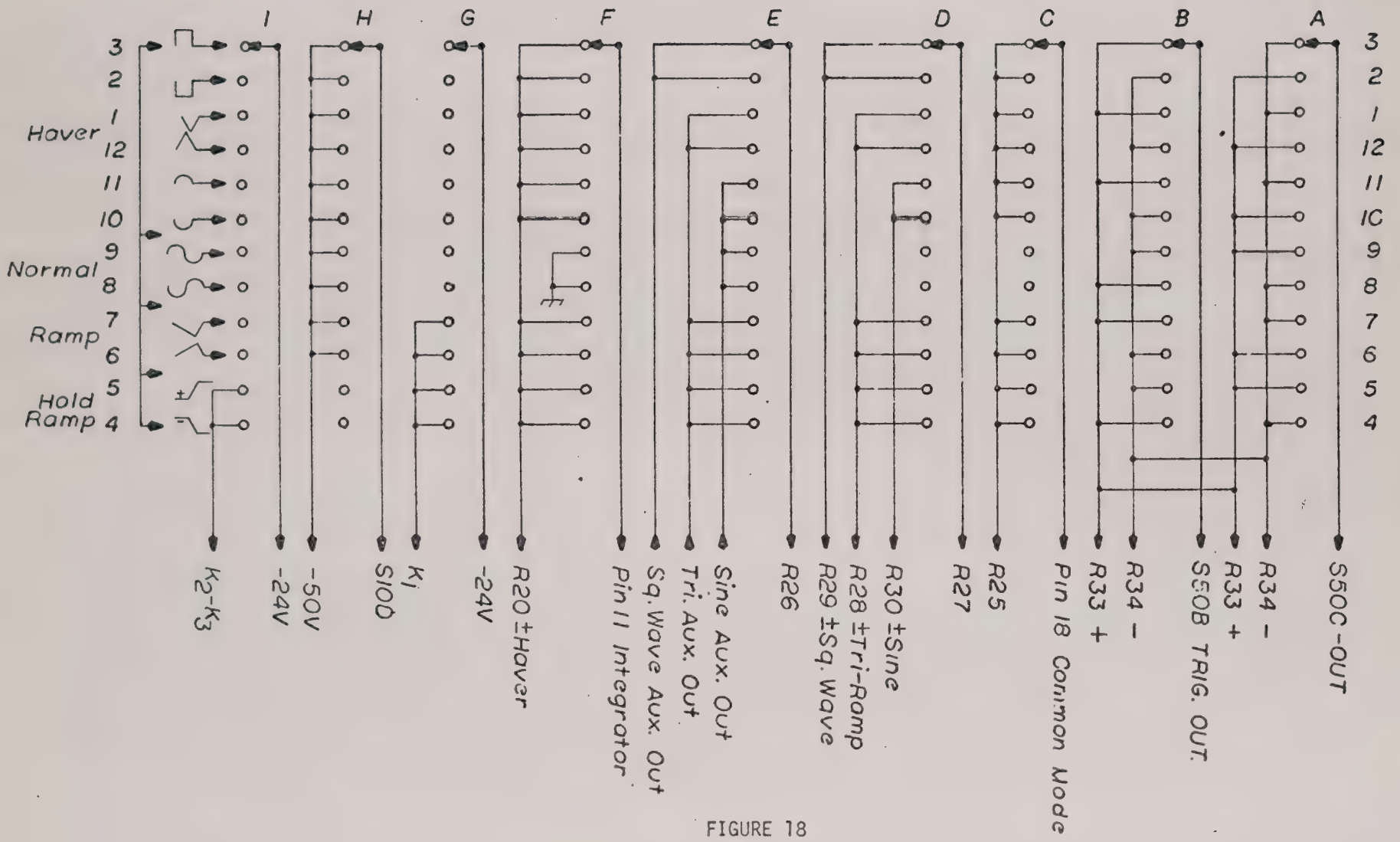


FIGURE 18

S60A-1 SWITCH DETAIL

SECTION 6 PARTS LIST

410.21 0169

POWER SUPPLY

R101	350Ω 10W WW resistor	308-3514
R103	3.4K ½W MF 1% res.	310-3401
R104	2.7K ½W comp 5% res.	301-272
R105	3.4K ½W MF 1% res.	310-3401
R106	1.2K ½W MF 1% res.	310-1201
R107	68.1K ½W MF 1% res.	310-6812
R108	13.7K ½W MF 1% res.	310-1372
R109	3.16K ½W MF 1% res.	310-3161
R110	13.7K ½W MF 1% res.	310-1372
R111	68.1K ½W MF 1% res.	310-6812
R112	3.24K ½W MF 1% res.	310-3241
R113	500Ω potentiometer	311-085
R114	100Ω ½W comp 5% res	301-101
R115	1.33K ½W MF 1% res.	310-1331
R117	3.4K ½W MF 1% res.	310-3401
R118	2.7K ½W comp 5% res.	301-272
R119	3.4K ½W MF 1% res.	310-3401
R120	1.2K ½W MF 1% res.	310-1201
R121	68.1K ½W MF 1% res.	310-6812
R122	13.7K ½W MF 1% res.	310-1372
R123	3.16K ½W MF 1% res.	310-3161
R124	13.7K ½W MF 1% res.	310-1372
R125	68.1K ½W MF 1% res.	310-6812
R126	3.24K ½W MF 1% res.	310-3241
R127	500Ω potentiometer	311-085
R128	1.33K ½W MF 1% res.	310-1331
R129	100Ω ½W comp 5% res.	301-101
D102	1N3027B zener diode	152-3027
D103	1N4058 zener diode	152-4058
D104	1N3027B zener diode	152-3027
D105	1N4058 zener diode	152-4058
C101	1mf 50V capacitor	290-001
C102	600mf 75V cap.	290-038
C103	.001 capacitor	283-000
C104	20mf 75V capacitor	290-008
C105	1mf 50V capacitor	290-001
C106	600mf 75V capacitor	290-038
C107	20mf 75V capacitor	290-008
Q101	2N3611 transistor	156-3611
Q102	2N3638 transistor	156-3638
Q103	2N3638 transistor	156-3638
Q104	2N3638 matched	157-3638
Q105	2N3638 matched	157-3638
Q106	2N3643 matched	157-3643
Q107	2N3643 matched	157-3643
Q108	2N3611 transistor	156-3611
Q109	2N3638 transistor	156-3638
Q110	2N3638 transistor	156-3638
Q111	2N3638 matched	157-3638
Q112	2N3638 matched	157-3638
Q113	2N3643 matched	157-3643
Q114	2N3643 matched	157-3643

T100	transformer	120-032
F100	fuse .8amp SloBlo	159-018
SW100	switch, power	260-134
P100	line cord	161-016
DS100	light, power	136-047

LEFT MOTHER BOARD

R10	100K ½W 5% comp	301-104
R21	10K ½W 5% comp	301-103
R22	1meg ½W 5% comp	301-105
R23	100K ½W 5% comp	301-104
C16	120pf capacitor	281-534
C17	.001mf capacitor	283-000
C19	.01mf capacitor	283-005
D13	1N1541 diode	152-1541

RIGHT MOTHER BOARD

R24	22.1K ½W 1% MF	310-2212
R25	22.1K ½W 1% MF	310-2212
R26	22.1K ½W 1% MF	310-2212
R27	75K ½W 1% MF	310-7502
R35	2K potentiometer	311-044
R36	10K potentiometer	311-043
C18	47pf capacitor	281-532

INTEGRATOR

R501	1K ½W 5% resistor	301-102
R502	95.3K ½W 1% res.	310-9532
R503	137K ½W 1% res.	310-1373
R504	137K ½W 1% res.	310-1373
R505	100K ½W 1% res.	310-1003
R506	100K ½W 1% res.	310-1003
R507	22.1K ½W 1% res.	310-2212
R508	2.7K ½W 5% res.	301-272
R509	22.1K ½W 1% res.	310-2212
R510	5.90K ½W 1% res.	310-5901
R511	18.2K ½W 1% res.	310-1822
R512	2.7K ½W 5% res.	301-272
R513	22.1K ½W 1% res.	310-2212
R514	1.5K 1W 5% res.	304-152
R515	4.7K 2W 5% res.	305-472
R516	22.1K ½W 1% res.	310-2212
R517	82.5K ½W 1% res.	310-8252
R518	68K ½W 5% res.	301-683
R519	100K ½W 5% res.	301-104
R520	42.2K ½W 1% res.	310-4222

INTEGRATOR (continued)

R521	68K ½W 5% res.	301-683
R522	47.5K ½W 1% res.	310-4752
R523	47.5K ½W 1% res.	310-4752
R524	22.1K ½W 1% res.	310-2212
R525	1K ½W 5% res.	301-102
R526	22.1K ½W 1% res.	310-2212
R527	1K ½W 5% res.	301-102
R528	20K potentiometer	311-083
R530	1K potentiometer	311-082
C501	8pf capacitor	281-535
C502	8pf capacitor	281-535
C503	.05mf capacitor	283-010
C504	120pf capacitor	281-534
C505	120pf capacitor	281-534
C506	.05mf capacitor	283-010
C507	5pf capacitor	281-501
C508	22pf capacitor	281-530
D501	1N1541 diode	152-1541
D502	1N914 diode	152-0914
D503	1N914 diode	152-0914
D504	1N914 diode	152-0914
D505	1N914 diode	152-0914
D506	1N1541 diode	152-1541
Q501	UCX2701 dual MOSFET	156-2701
Q503	2N3643 matched trans	157-3643
Q504	2N3643 matched trans	157-3643
Q505	2N699 matched trans	157-0699
Q506	2N699 matched trans	157-0699
Q507	2N699 transistor	156-0699
Q508	2N4045 dual NPN trans	156-4045
Q510	2N4045 dual NPN trans	156-4045

SCHMITT

R401	13.0K ½W MF 1% res.	310-1302
R402	15.0K ½W MF 1% res.	310-1502
R403	49.9K ½W MF 1% res.	310-4992
R404	100K ½W comp 5% res.	301-104
R405	5.49K ½W MF 1% res.	310-5491
R406	5K ½W MF 1% res.	310-502
R407	49.9K ½W MF 1% res.	310-4992
R408	17.4K ½W 1% MF res.	310-1742
R409	5K ½W MF 1% res.	310-502
R410	5.49K ½W 1% MF res.	310-5491
R411	7.15K ½W 1% MF res.	310-7150
R412	63.4Ω ½W 1% MF res.	310-634
R413	324Ω ½W MF 1% res.	310-3240
R414	800Ω 3W WW 5% res.	308-8011
R415	4.7K ½W comp 5% res.	301-472
R416	2.5K 5W WW 5% res.	308-2522
R417	2K potentiometer	311-086
R418	3.16K ½W 1% res.	310-3162
R419	1K ½W MF 1% res.	310-1001
R420	18.2K ½W MF 1% res.	310-1822
R421	18.2K ½W MF 1% res.	310-1822
R422	1K ½W comp 5% res.	301-102
R423	22Ω ½W comp 5% res.	301-220
R424	22Ω ½W comp 5% res.	301-220
R425	1K ½W comp 5% res.	301-102
R426	1M ½W comp 5% res.	301-105
R427	20K potentiometer	311-083
R428	20K potentiometer	311-083
R429	2K potentiometer	311-086
R430	1K potentiometer	311-082
R431	1K potentiometer	311-082
C401	47pf capacitor	281-532
C402	270pf capacitor	281-540
C403	.05mf disc	283-010
C404	.05mf disc	283-010
C405	390pf capacitor	281-556
D401	1N914 diode	152-0914
D402	1N914 diode	152-0914
D403	1N968B zener diode	152-0968
D404	TI55 diode	152-0055
D405	TI55 diode	152-0055
D406	1N914 diode	152-0914
D407	1N914 diode	152-0914
D408	1N4058 zener diode	152-4058
D409	1N914 diode	152-0914
D410	1N914 diode	152-0914
Q401	2N3638 matched	157-3638
Q402	2N3638 matched	157-3638
Q403	2N3643 matched	157-3643
Q404	2N3643 matched	157-3643
Q405	2N699 transistor	156-0699
Q406	2N699 transistor	156-0699
Q407	2N699 transistor	156-0699
Q408	2N4889 transistor	156-4889

SINE SHAPER

R701	12.7K ½W MF 1% res.	310-1272
R702	1M ½W MF 1% res.	310-1004
R703	6.81K ½W MF 1% res.	310-6811
R704	221Ω ½W MF 1% res.	310-2210
R705	4.75K ½W MF 1% res.	310-4751
R706	221Ω ½W MF 1% res.	310-2210
R707	562Ω ½W MF 1% res.	310-5620
R708	12.1K ½W MF 1% res	310-1212

SINE SHAPER (continued)

R709	562Ω ½W MF 1% res.	310-5620
R710	909Ω ½W MF 1% res.	310-9090
R711	33.2K ½W MF 1% res.	310-3322
R712	909Ω ½W MF 1% res.	310-9090
R713	1.5K ½W MF 1% res.	310-1501
R714	56.2K ½W MF 1% res.	310-5622
R715	1.5K ½W MF 1% res.	310-1501
R716	2.21K ½W MF 1% res.	310-2211
R717	100K ½W MF 1% res.	310-1003
R718	2.21K ½W MF 1% res.	310-2211
R719	4.02K ½W MF 1% res.	310-4021
R720	22.1K ½W MF 1% res.	310-2212
R721	4.02K ½W MF 1% res.	310-4021
R722	1.2K ½W comp 5% res.	301-122
R723	2.7K ½W comp 5% res	301-272
R724	5.6K ½W comp 5% res	301-562
R725	2K potentiometer	311-086
R726	100K potentiometer	311-087
D701	1N935A zener diode	152-0935
D702	through D713:	
	1N914 diode	152-0914
D714	TI55 diode	152-0055
D715	TI55 diode	152-0055
D716	1N935A zener diode	152-0935
D717	1N935A zener diode	152-0935
C701	.05mf capacitor	283-010
Q701	2N699 transistor	156-0699
Q702	2N4889 transistor	156-4889

SINE AMPLIFIER

R801	100K ½W comp 5% res.	301-105
R802	100K ½W MF 1% res.	310-1003
R803	137K ½W MF 1% res.	310-1373
R804	137K ½W MF 1% res.	310-1373
R805	100K ½W comp 5% res.	301-105
R806	49.9K ½W MF 1% res.	310-4992
R807	2.7K ½W comp 5% res.	301-272
R808	22.1K ½W MF 1% res.	310-2212
R809	22.1K ½W MF 1% res.	310-2212
R810	7.50K ½W MF 1% res.	310-7501
R811	22.1K ½W MF 1% res.	310-2212
R812	2.7K ½W comp 5% res.	301-272
R813	22.1K ½W MF 1% res.	310-2212
R814	470Ω ½W comp 5% res.	301-471
R815	1K potentiometer	311-082
C802	8pf dipped mica cap	281-535
C803	.05mf dipped mica	283-010
C804	120pf dipped mica	281-550
C805	120pf dipped mica	281-550

SINE AMPLIFIER (continued)

C806	.05mf dipped mica	283-010
C807	8pf dipped mica	281-535
Q801	F5085 FET trans.	156-5085
Q802	F5085 FET trans.	156-5085
Q803-4	2N3643 matched	157-3643
Q805	2N699 transistor	156-0699
Q806	2N699 transistor	156-0699
Q807	2N699 transistor	156-0699

GATE LOCKOUT

R600	2.7K ½W comp 5%	301-272
R601	82K ½W comp 5%	301-823
R602	33K ½W comp 5%	301-333
R603	270K ½W comp 5%	301-274
R604	4.7K 1W comp 5%	304-472
R605	82K ½W comp 5%	301-823
R606	270K ½W comp 5%	301-274
R607	33K ½W comp 5%	301-333
R608	4.7K 1W comp 5%	304-472
R609	4.7K 1W comp 5%	304-472
R610	5.6K ½W comp 5%	301-562
R611	27K ½W comp 5%	301-273
R612	270K ½W comp 5%	301-274
R613	82K ½W comp 5%	301-823
R614	10K ½W comp 5%	301-103
R615	15K ½W comp 5%	301-153
R616	4.7K ½W comp 5%	301-472
C600	47pf capacitor	281-532
C601	47pf capacitor	281-532
C602	270pf capacitor	281-540
C603	47pf capacitor	281-532
C604	22pf capacitor	281-530
C605	270pf capacitor	281-540
Q601	2N699 transistor	156-0699
Q602	2N699 transistor	156-0699
Q603	2N699 transistor	156-0699
Q604	2N699 transistor	156-0699
D600	1N914 diode	152-0914
D601	1N914 diode	152-0914

OUTPUT AMPLIFIER

R1901	137K 1% MF res.	310-1373
R1902	137K 1% MF res.	310-1373
R1903	100K 5% comp res.	301-104
R1904	110K 1% MF res.	310-1103
R1905	1K potentiometer	311-082
R1906	100K 5% comp res.	301-104
R1907	10K 1% MF res.	310-103

OUTPUT AMPLIFIER (continued)

R1908	5.90K 1% MF res.	310-5901
R1909	22.1K 1% MF res.	310-2212
R1910	1.2K 1W 5% res.	304-122
R1911	22Ω ½W 5% res.	301-220
R1912	22Ω ½W 5% res.	301-220
R1913	1.2K 1W 5% res.	304-122
R1914	1.2K 1W 5% res.	304-122
R1915	22Ω ½W 5% res.	301-220
R1916	22Ω ½W 5% res.	301-220
R1917	1.2K 1W 5% res.	304-122
R1918	22.1K 1% MF res.	310-2212
R1919	4.7K 5% comp res.	301-472
R1920	5K 1% MF res.	310-5001
R1921	54.90K 1% MF res.	310-5492
R1922	49.9K 1% MF res.	310-4992
R1923	1K potentiometer	311-082
R1924	54.9K 1% MF res.	310-5492
R1925	47Ω 5% comp res.	301-470
R1926	5.90K 1% MF res.	310-5901
R1927	10K 1% MF res.	310-1002
R1928	500Ω potentiometer	311-085
R1929	47Ω 5% comp res.	301-470
R1930	10K 1% MF res.	310-1002
R1931	10K 1% MF res.	310-1002
C1904	.01mf disc cap	283-005
C1905	.01mf disc cap	283-005
C1906	.01mf disc cap	283-005
C1907	.01mf disc cap	283-005
C1908	120pf capacitor	281-534
C1909	47pf capacitor	281-532
C1910	12pf capacitor	281-541
C1911	8pf capacitor	281-535
C1912	22pf capacitor	281-530
C1913	8pf capacitor	281-535

Q1900	F5085A matched P channel FET	157-0005
Q1910	F5085A matched P channel FET	157-0005
Q1920	2N699 transistor	156-0699
Q1930	2N699 transistor	156-0699
Q1940	2N699 transistor	156-0699
Q1950	2N4889 transistor	156-4889
Q1960	2N699 transistor	156-0699
Q1970	2N4889 transistor	156-4889
Q1980	2N3638 transistor	156-3638
Q1990	2N3638 transistor	156-3638
Q2000	2N699 transistor	156-0699
Q2010	2N699 transistor	156-0699
D1901	TI55 diode	152-0055
D1902	TI55 diode	152-0055
D1903	TI55 diode	152-0055
D1904	TI55 diode	152-0055

PRESSBOARD BINDER

GENUINE TYPE 1 PRESSBOARD

STOCK NO. B118 NO FASTENERS
STOCK NO. B118-84 FASTENERS INSTALLED 8½" C.C.